The Benefits of Screw Pumps in Oil Production, Transport and Storage

While centrifugal pumps have traditionally been the dominant technology in these applications, the many operational advantages of screw pumps can make them a better alternative

By Lihui Wang

Oil production, transport and storage is a complex business, with hundreds of fluids needing to be handled in the manufacture of a multitude of end products. Over the years, centrifugal pumps have been the first-choice pumping technology in these applications, but positive displacement pumps - in this case, Blackmer® S Series Twin Screw Pumps With Timing Gear (WTG) - are proving to be a better option for the transfer of high-viscosity fluids at high and consistent flow rates.

INTRODUCTION

The oil industry is a complex one that spans from the discovery of underground reserves to their recovery, gathering, refining, manufacturing, transport, storage and eventual marketing as consumer goods that cover a product range from motor fuels and plastics to chemicals and cosmetics. Throughout the various points in this massive, complicated production and supply chain, pumps are needed to move fluids and gases to and from numerous production, transport and storage points.

Choosing the right pump demands that strict attention be paid to the traits and characteristics of the fluid to be handled; things such as viscosity, temperature, corrosiveness, and solids and gas content are among the most significant. Because of the complexity of oil-production regimes, the pumps must also be flexible; it's easy to identify a pump that can move one specific fluid in static working conditions, but what are the options when more than 100 different types of fluids in changing operating atmospheres must be conveyed?

For many years, the pumping technology of choice in many fluid-transfer applications in oil production has been the centrifugal pump. Centrifugal pumps can perform admirably in these situations because of their method of operation – fluid enters the pump impeller at the rotating axis and is accelerated by the impeller, flowing radially outward at high speed into the volute discharge port. The rotation of the fluid increases its kinetic energy and converts it into the pressure that drives the transfer process. This allows centrifugal pumps to produce the high-volume flow rates required to transfer the many low-viscosity fluids that need to be transported through the networks of piping used in the production of oil and oil-based products,

While centrifugal pumps have been used successfully in oil applications, positive displacement (PD) pumps

can also play a role. For example, the operation of a PD screw pump pushes the fluid forward as volume changes and pressure increases. This creates a pumping action that can handle high-viscosity fluids while still producing high and consistent flow rates.

By using different pump technologies to handle the dizzying array of fluids that play a role in the oil-production process, operators can face an uphill task in identifying the proper one for each specific application. This white paper will attempt to illustrate how PD twin-screw pumps, rather than centrifugal pumps, can be a versatile, reliable and efficient choice in all critical fluid-handling operations in the wide-ranging oil industry.

THE CHALLENGE

In many cases, oil production and processing systems have been designed around the pumping technology, rather than the other way around. And since many of the fluids that are handled during oil production have very low viscosities and must be transferred at very high flow rates, centrifugal pumps have become the technology of choice. That approach can be shortsighted, however, if you want to optimize an oil-production fluid-handling operation.

That's because many of the fluids that flow through the oil-production process – from oilfield to tank farm to service station – are more than thin and water-like, which makes them much more difficult for centrifugal pumps to adequately handle. In fact, a typical tank farm may have upwards of 100 unique fluids enter it during the course of the day, including crude oil, gasoline, diesel fuel, aviation kerosene, benzene, solvents and a complete menu of various other chemicals.

The range of fluids has a correspondingly wide range of characteristics, some being very viscous, while others may contain some level of solids or entrained gas, or be highly corrosive. Therefore, many tank-farm operators have used many different types of pumps to convey the different types of fluids that enter their gates. While the pumps may be able to perform the required task, an expansive roster of pump technologies increases the complexity of the fluid-handling operation. This makes it more difficult to manage the equipment, with higher maintenance, repair and replacement cost a typical outcome.

This need for strict attention to the operational window is especially true for centrifugal pumps. Centrifugal pump function best at what is known as their "Best Efficiency Point," or BEP. The BEP is the spot where the centrifugal pump is working at its highest level of efficiency. Centrifugal pumps rarely operate at their exact BEP because pristine pumping conditions are rarely achieved, but a centrifugal pump that is able to function in a

Simply relying on centrifugal pumps in all oil production, transport and storage applications because "that's the way it's always been done" can be shortsighted and ineffective. The range of fluids being handled, from water-like to highly viscous, requires a more versatile pump, and Blackmer® S Series Twin Screw Pumps can meet that demand.

A number of notable design enhancements enable Blackmer® S Series Twin Screw WTG Pumps to achieve the highest flow rates of any rotary PD pump technology, even at varying backpressures and fluid viscosities. This makes them ideal for handling the many unique fluid types that are prevalent in oil production, transport and storage.

window between 80% and 110% of tits BEP is said to be functioning adequately.

However, when the operation of the pump moves too far off its BEP uneven pressure will be applied to the impeller, which can result in the increased radial thrust that will cause the pump's shaft to "deflect." When this deflection occurs, higher loads will be placed on the bearings and mechanical seal, which can lead to damage to the pump's casing, backplate and impeller. Ensuring operation at the BEP can be a time-intensive task as the pump must be monitored constantly and adjusted, which costs time and money.

Additionally, meeting production rates and quotas has always been job No. 1 in oil-production operations, but as operating costs have continued to rise, there has been a call for increased operational efficiency in terms of the amount of energy that is required and consumed during pumping operations. In this area, centrifugal pumps can also fall short:

- Over-sized pumps are often chosen, resulting in increased operating and maintenance costs, inefficient operation and higher-than-necessary energy consumption
- As the pump's differential pressure increases, the flow rate decreases. Therefore, time-sensitive operations that must maintain a constant flow rate will take longer, which may be costly.
- The performance of a centrifugal pump will be adversely affected when pumping a high-viscosity fluid

So, a question that the operator of an oil-processing operation who is leery of relying too heavily on centrifugal pumps while also looking for ways to limit the complexity and overall cost of the operation, and meeting production quotas, might ask, "Is there a pump available that can balance stability, handle varying viscosities, flow rates and pressures, have good chemical compatibility, and be easy to maintain and use?"

THE SOLUTION

The answer to that question is a resounding, "Yes," and it is found in the PD twin-screw pump. In general, twin-screw pumps can shine in the many different fluid-handling applications in oil production because they can create high head pressures, have a stable flow, are self-priming and highly efficient. Screw pumps also boast some specific additional advantages: compatibility with a wider range of fluids, ability to create high flow rates and high pressures, low pulsation and low shear, short-time dry-run operation, and an ability to transfer multi-phase fluids.

The design of the twin-screw pump, which sees the continuous rotation of two non-contacting spiral rotors that push the fluid to the discharge port, enables it to operate very smoothly with no excessive noise or vibration. Since the pump's bearings and synchronous gears never contact the fluid that is being transferred, there is never any fear that these components will be damaged by any kind of corrosive media.

This chart illustrates the advantages that screw pumps can boast when compared to centrifugal pumps in oil-production processes:

Category	Centrifugal Pump	Twin-Screw Pump
Pump Startup	No self-priming capability, so pump must be primed before startup	Has self-priming ability, so priming is only required when it is used for the first time
Flow Regulation	Must regulate the outlet valve or pump speed	Regulate the bypass return valve or pump speed
Viscosity Influence	Good for low-viscosity fluids, but flow rate will drop rapidly as viscosity rises	Suitable for conveying low-viscosity fluids with more stable flow rates when handling high viscosities
Entrained Gas Influence	Gas in the fluid will result in sluggish flow	Can easily handle multi-phase fluids
Pump Stopping	Outlet valve must be shut before stopping pump	Outlet valve can be shut after stopping the pump

Realizing the operational advantages that can be achieved when using screw pumps in oil-processing fluid-transfer applications, Blackmer®, Grand Rapids, MI, USA, a leading provider of pumps and compressors for industrial use, and a product brand of PSG®, Oakbrook Terrace, IL, USA, a Dover company, has developed the S Series Twin Screw With Timing Gear (WTG) Pump model. This model is available for purchase and use by customers of PSG China, a subsidiary of PSG that is headquartered in Tianjin, China.

The Twin Screw (WTG) pumps have been designed with external bearings and a timing-gear transmission, which produces double-suction, self-priming operation with no metal-to-metal contact between the pump's internal components.

More specifically, two design innovations stand out in the Blackmer Twin Screw WTG Pumps that help differentiate them from the competition:

- **Patented Rotor Profile:** Taking into account the complexity found in transferring different types of fluids, the Twin Screw WTG pumps have an optimized rotor profile that enables them to produce higher volumetric efficiency and stronger self-priming capability. This allows them to perform very well with the many harsh fluids that are encountered in oil production.
- **Interchangeable Single/Double End-Face Seal:** The mechanical seal is a major wear part on twin-screw pumps, so although the double end-face seal design is more complicated and expensive, it greatly improves the service life and reliability of the mechanical seal. The pump has also been designed to allow for the use of an interchangeable single end-face seal, which gives more flexibility to the pump's user since it can be upgraded to the double end-face model when necessary.

All of these design advances enable the S Series Twin Screw (WTG) pump to achieve the highest flow rates of any rotary PD pump, even at varying backpressures and viscosity levels. In fact, the deliverable flow rate of a PD screw pump, unlike a centrifugal pump, actually increases as the fluid's viscosity increases. These design characteristics also make screw pumps suitable for all types of transfer applications, including low- or high-viscosity, lubricating or non-lubricating, neutral or aggressive, solid-laden or pure, and clean or contaminated fluids.

CONCLUSION

Twin-screw pumps have been playing an important role in the oil industry for many years, but now is the perfect time to acknowledge the design and operational advantages that make them ideal replacements for less-effective centrifugal pumps and other technologies that are commonly used in the many fluid-handling applications that are inherent in oil production. Since screw pumps are also incredibly versatile, operators will no longer need to spend time and money learning, choosing, using and maintaining a wide range of pump technologies that will only ultimately needlessly increase the complexity and cost of their operations.

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