Swapping to a rigless system

How an electric submersible pump system can save money and improve safety

By John Algeroy & Greg Nutter, AccessESP

Operators may reduce the cost of operating electric submersible pump (ESP) wells by installing an ESP deployment system, which allows the ESP to be replaced through tubing using slickline. The technology can be beneficial in remote areas such as the Arctic, jungles, deserts or offshore locations, where changing a traditional ESP would take a long time because of rig availability/scheduling or cost a substantial amount because of loss of production.

The rigless ESP conveyance system was featured in the industry's first pump swap for an operator on the North Slope of Alaska, an extremely remote oil field located within the Arctic Circle. Because rig availability is limited in this region, the time to replace a standard ESP can be up to six months while operators wait for the well workover to be placed on the drilling rig schedule, with the knock-on effect of a complete loss of production during this period. By implication, if production is 750 barrels per day, $6.75 million can be lost over 180 days at a price of $50 per barrel (bbl). The cost of using a drilling rig to replace the pump needs to be added to this sum, which is in the range of $2 million per swap.

Overall, drawbacks to the traditional system are the extensive time and large amount of money needed to replace the pump. Lost production and the workover cost means a total loss of around $8.75 million for the operator. Alternatively, the new system can perform the same work in approximately two to three weeks. The new system requires, in comparison, around two weeks (750 bbl per day x 14 days x $50/bbl = $525,000) of stopped production while waiting for the slickline unit to be scheduled and two days for the ESP pump to be replaced ($575,000). The total cost of using the new system is around $600,000, 7 percent of the cost of the traditional ESP swap of approximately $8.75 million.

Optimized for well conditions

Today ESPs are never replaced unless they have failed. This means the design of the pumps must cover at least three years of the life of the well. During this time, production rates typically change. The production composition may also change from mostly oil to a mixture of oil and water. Therefore, it is necessary for the pump design to have a large operating range. This means that for most of the pump's life, it will not operate in an optimal range. It is designed to operate at a point that is a compromise between the total flow rate and the life of the pump. In the new system, the pump can be retrieved at any time to be optimized for the current known well conditions while leaving the motor in the well. Therefore, the pump may operate at a higher level of efficiency based on the actual well conditions, not from a design based on planned production. This affords the operator an optimized pump design with reduced lifting costs, longer pump run life and lower overall horsepower required to lift fluid to the surface.

Technology

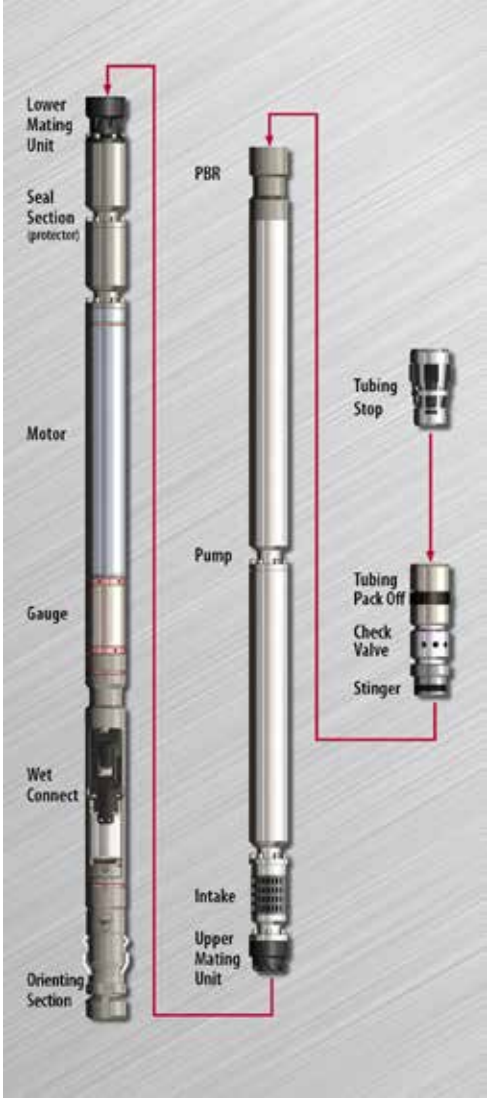
In the "rigless" conveyance system, a robust production-tubing landing string is combined with a side pocket-mounted downhole wet connector and a high-power permanent magnet motor (PMM).

Permanent completion system

This part of the system is deployed with the production tubing and comprises two components: the side pocket-mounted downhole wet connector and the connector orientation and latching system. Electrical power is provided via the ESP cable to the surface. The PMM is compatible with surface electrical equipment (variable speed drives, step-up transformers, downhole cables and wellhead/packer penetrators) from all major suppliers. The client's surface electrical equipment can, therefore, remain the same.

Slickline retrievable ESP assembly

The slickline retrievable assembly integrates the PMM and wet connect system with industry-standard ESP components (pumps, gas handling equipment, seals, cables) from all major ESP providers to allow the operator to combine the system with ESP components from various suppliers. The lightweight, high-power density PMM is one-fifth of the weight and length of conventional ESP induction motors. Following the deployment of the permanent completion, it takes a few hours to complete the through tubing installation of the slickline assembly. The retrieval of the



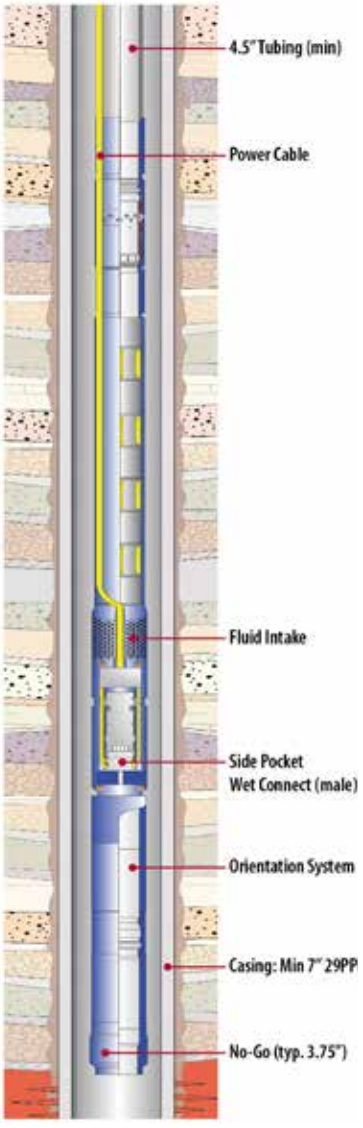


Figure 1. (Above) Retrievable system
Figure 2. (Right) Illustration of permanent completion
All graphics courtesy of AccessESP

slickline assembly also takes a few hours and is essentially the reverse of the installation. The wet connector on the retrievable ESP assembly is aligned with the mating connector on the permanent completion before engagement. The mechanical forces generated by the retrievable ESP system are taken by mechanical supports provided by the permanent completion.

Technical process

The slickline retrievable assembly is installed in four runs, allowing the operator flexibility, minimizing run lengths and optimizing jar action if needed in sandy or debris-prone environments (see Figure 1).

- **Run one** — The wet-connect and motor assembly
- **Run two** — The pump and a mechanical unit ensure torque transfer from the motor
- **Run three** — Seals off the system against the tubing and avoids recirculation during operation
- **Run four** — The tubing stop locks the retrievable system in place

A rigorous test procedure

A global operator assisted in the development of the new system because of concerns surrounding the high associated costs of replacing ESP pumps. The companies worked side by side to develop a system that would meet the design specifications of the operator and consequently could be used in other operators' wells. The operator provided direction and assistance by allowing the system to be installed in a full-scale test well in Midland, Texas. This testing was finished before any installations were performed on producing wells. The time spent practicing on a test well confirmed that when the operation is attempted at the customer's well site, it will be a success. Lessons learned during the operations at the test well were written into the operating procedure used at the well site to swap the ESP carefully with no health, safety and environmental incidents and in a minimal amount of time.

Numerous successful installations and retrievals have since been performed, including with the entire system (runs one through four as well as pump swap) and with runs two through four while leaving the motor in the well and connected. These operations have been performed mostly with slickline, but also successfully with coiled tubing, wireline tractor and pump-assisted.

Summary

Slickline retrievable ESP systems are now a commercially viable technology proven in challenging environments and successfully operating in fields globally. The application of this technology significantly reduces operating costs, capital expenditure and cost per barrel for operators in a large segment of the global ESP market while actively increasing rates of production. FC

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