BP installs first dual ESP system at Wytch Farm

Environmentally sensitive location gets downhole backup pump to reduce workover requirement.

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BP has recently installed a REDA dual electrical submersible pump (ESP) system from Schlumberger at Wytch Farm oil field, Dorset, England. The system, designed for redundant operation, will enable BP to reduce workover frequency by increasing ESP system run-life. Wytch Farm is a mature field in an environmentally sensitive area. Any reduction in workover frequency is seen as a big win within BP.

ESPs installed in similar Wytch Farm wells have achieved run-lives in excess of 1,500 days. Therefore, the new ESP assemblies were designed to account for changing reservoir conditions over this period and feature two different pump configurations, with plans to switch operation between the two systems in the future. Gauges that allow the use of a 24-hr surveillance, monitoring and optimization service also were installed.

Described here are: the background of dual ESPs to reduce workover costs; need for the dual system in Wytch Farm’s environmentally sensitive Well L-12; design features of the system; and delivery and installation in September 2004.

BACKGROUND

Over the past eight years, Schlumberger companies have been involved in the installation of more than 30 oil well completions equipped with two ESPs. The second pump is intended as a backup (or redundant) device to be used should the first pump fail.

Most of these 30 wells are located offshore, where interventions to replace a failed pump involve using a mobile offshore drilling unit or an existing platform drilling rig. The cost of such an operation is usually charged as an operating expense to the well, platform or field. Consequently, cost and frequency of workovers, when combined with lost revenue from deferred oil production while scheduling a workover, can significantly impact operating costs. This especially affects the economic viability of mature fields or other marginal developments.

The redundant-pump strategy is intended to reduce the number of workovers over the life of a well, and, thus, cost. The Wytch Farm well needing a new ESP presented a further powerful motive to minimize workovers—it is located on a small island off the southern coast of England in Poole Harbour, Dorset, England, Fig. 1. This region has been described as, “nationally important . . . one of the richest in lowland Britain for diversity of natural habitats and many important nature reserves,” by the Poole Harbour Study Group. Exposure to a potential HSE (Health, Safety and Environment) incident can be directly related to the amount of well intervention activity undertaken by the operator. BP is thus diligent about minimizing interventions.

Fig. 1. Looking east over Poole Harbour, Round Island is in the foreground and Furzey Island (oil derrick indicates Wytch Farm location) lies beyond. (Photo courtesy J. P. Allen, Images of Dorset).
SPECIAL FOCUS  INTELLIGENT WELL COMPLETIONS

oil field in Western Europe. The development comprises eight mainland well sites, plus two on nearby Furzey Island, Fig. 2. The field has 57 wells actively producing, plus 26 injectors; it has an estimated 500 MM bbl of recoverable oil. First oil was produced in 1960.

Wytch Farm encompasses three primary reservoirs: Frome at 800 m (2,625 ft), Bridport at 924 m (3,032 ft), and Sherwood at 1,585 m (5,200 ft). The Wareham and Kimmeridge formations are also oil productive in the area.

Well L12, situated on Furzey Island, produces from the Sherwood formation. Following a lateral sidetrack in 2003, L12 was completed with a single ESP system. After initially producing 5,000 bopd with low water cut, the well declined substantially to 2,000 bopd and the ESP suffered premature failure from low flow.

When considering next steps, uncertainty arose about what rate of future production to expect. A subsequent ESP workover could result in an oversized pump if the well continued to decline, or an undersized pump should production stabilize. Both scenarios had potential for further workovers in the future, which would require rig moves at significant cost and environmental risk.

In an attempt to avoid such a rig move to Furzey Island, a jet pump was installed in a sliding sleeve above L12’s existing ESP assembly. It was thought that the jet pump might achieve an acceptable production rate and help characterize future well performance. The jet pump produced around 600 bopd, but it also provided time to gather well performance data and hence determine a more accurate rate prediction for an ESP. A decision was then made to workover the well and install a new ESP.

A maximum run-life for the new installation was obviously desired. Familiar with backup ESP systems, BP had already considered using this technology to minimize workover costs and prolong the economic life of well in the Wytch Farm development. Well L12 offered both the opportunity to implement a backup system and install two different pump sets in the same well to cope with changing reservoir conditions over time.

SYSTEM DESIGN

The redundant system used comprises two complete ESPs, each deployed on a bypass system, Fig. 3. A pump-support sub, from which the lower ESP/bypass system is hung, is included at the base of the upper ESP bypass.

To operate the lower ESP, a blanking plug is set in a nipple profile below the lower Y-tool to prevent recirculation. An isolation tool straddles two other nipple profiles, above and below the upper Y-tool. This serves to isolate the upper ESP while the lower is operating, and creates the production flow path, Fig. 4.

Production can be switched to the upper ESP by removing the isolation tool and installing a second blanking plug in the nipple profile below the upper Y-tool. The second blanking plug prevents recirculation of the upper ESP during operation.

The existing lower completion in Well L12 includes a sliding sleeve. Access to the sleeve was a design requirement for any new artificial lift completion. The dual-bypass system was the ideal solution to maintain the intervention path, while enabling a backup ESP system to be deployed.

The dual-bypass system had to fit within the 9¾-in., 40.0-pf f casing and accommodate the selected 5.40-in. OD ESP set. To optimize the lower ESP sizing, the largest size of bypass tubing possible was used for the upper ESP bypass assembly. This was 2¾-in. VAM FJL flush-joint tubing.

The nipple sizes in the dual-bypass assembly were dictated by the bypass tubing size, and the need to maintain access to the sliding sleeve in the lower completion. It was possible to use the standard...
With this in mind, the upper and lower ESP assemblies were configured differently. The lower assembly, which will be used first, includes a 125-hp motor. The upper assembly includes a 150-hp motor and additional pump stages so that the target flow rate can be maintained when water cut increases. An advanced gas handler will accommodate the predicted rise in gas-to-oil ratio over time. BP expects to switch production to the upper ESP system after about 2.5 years to maintain optimal performance as conditions change.

Included with each of the ESP assemblies is a Phoenix MultiSensor, Type 1 gauge, which measures pump intake pressure, pump discharge pressure, intake temperature, motor winding temperature, vibration and current leakage.

**SYSTEM DELIVERY**

To coincide with planned rig movements, and avoid additional rig moves, BP wanted the workover to occur just six weeks after placing the order for the dual-ESP system. With this in mind, the system was designed to use standard 9½-in. bypass equipment. The use of standard equipment enabled system design and manufacturing to go quickly and meet delivery targets.

Prior to delivery to Wytch Farm, a stack-up test of the complete ESP bypass assembly was performed in a test well at Schlumberger’s Artificial Lift Facility in Inverurie, Scotland. This was the first time a complete dual-bypass system had been installed in the 250-ft test well, and it avoided the requirement to use a third-party test well. The stack-up was witnessed by BP and carried out to verify the mechanical fit and ensure that the running procedure covered all the necessary steps for successful installation in Well L12.

In conclusion, the system was installed without incident in September 2004. In accordance with the planned operating strategy, the blanking plug was set in the lower system telescopic swivel nipple, and the isolation tool was set across the top nipple and upper telescopic swivel nipple, isolating the upper ESP and creating the flow path for the lower ESP. The lower ESP was started and is producing 2,450 bopd with a water cut of 38%.

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