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Reverse-Circulation Cementing To Seal a Tight Liner Lap

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Abstract

Drilling in the Arctic can present a number of challenges even before the drilling begins. Among the challenges are logistic difficulties, weather extremes, and environmental sensitivities. To offset the production decline for natural gas in North America operators must confront these challenges by resuming exploration in the Arctic.

The target in this case study is a well in the Paktoa field. The design challenge presented by this well was to drill the well to total depth (TD) with the lowest number of casing strings while avoiding remedial cementing operations. Given that the mud-weight window predicted for this wellbore was quite narrow, well planners determined that no fewer than five casing strings were needed to reach TD. Multiple casing strings can lead to tighter annuli and more challenging cementing operations.

Using modeling software as an aid to cement design, planners determined that the cement on the first liner, from 1,300 to 2,600 ft, could not be circulated conventionally without breaking down the formation because of the high equivalent circulating density (ECD). The greatest contributor to the high ECD is the tight annulus of the liner lap. The model parameters were reversed and the model predicted that a reverse-circulation cementing (RCC) operation would be successful.

RCC is a method of pumping cement down the annulus and receiving returns inside the casing. One advantage of reverse circulating is that the ECD is reduced and less pressure is exerted on the formation. This will help reduce or eliminate cement losses into weak formations.

Placing the cement down the annulus appeared to be feasible with the computer model but to conduct the operation in the field, other challenges were addressed. In a reverse operation, the float valve is removed or sheared out before pumping cement. This is not of concern with a normal casing string but with a liner, the drillpipe is detached and the cement will drop until the pressure is balanced at the shoe. To prevent the cement drop, two flapper valves were installed such that the liner running tool and slick stinger could stab in and circulation could be established.

The RCC operation on the liner was successfully conducted. This paper presents a case history of the reverse-circulation cementing operation.

Background/Introduction

The Beaufort Sea, located between Alaska and the Northwest Territories, is the focus of recent exploration, with Devon Canada returning to the Canadian Beaufort Sea to drill the first offshore well started since 1991. Using 3D seismic mapping technology, Devon has narrowed its emphasis to the Paktoa field, an area that indicated significant gas reserves.

The drilling platform used by Devon was designed for Beaufort Sea drilling and christened in 1982; the SDC (steel drilling caisson) was built from the hull of a retired oil supertanker (**Fig. 1**). Since 2002, the SDC drilling rig has been in cold storage waiting for exploration to resume. The rig was refurbished, upgraded, and towed to its present location (during the summer months). Once on-site, it was lowered to the shallow seafloor of the Beaufort where it waited for the winter freeze and drilling to commence. **Fig. 2** shows that environmental impact is an important concern to operators in the Beaufort operating area.

To drill safely to the targeted 7,700 ft, Devon Canada engineers designed the well with five casing strings (**Fig. 3**). The design resulted in tight annuli between the casings and more challenging cement designs. The Devon engineers asked Halliburton for a design to ensure that cement returns were achieved.

The most challenging casing string to cement in this well design was the 11 ¾-in. intermediate liner from 1,300 to 2,600 ft, inside a 13 ⅝ in. surface casing string. At this depth, an unconsolidated formation with a low fracture gradient prevented a conventional cement job to be conducted, so planners chose to reverse circulate the cement in place. The advantage of reverse circulation cementing for this casing string is lower ECD, helping ensure a competent cement sheath at the liner lap. Cement returns in the casing were not an issue since the cement in this stage would be drilled out for the next string.

Originally modeled with the beta version of a proprietary Halliburton cement-job planning software package, the cement design was then reconfirmed with a later release. The capability to model this reverse cement job and review the

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