Auto-Fill tool cuts formation surge pressures and stops expensive mud losses

Anuar Taib, Shell Offshore Inc

Hank Rogers and Seth Moore, Halliburton Energy Services Inc

SHELL OFFSHORE INC has significantly reduced expensive mud losses in wellbores with tight clearances by reducing the piston effect caused by lowering casing through other casings where the narrow annulus presents a tight-tolerance fit. This tight-tolerance condition exists when wells are underreamed below a casing string and when the inside diameter of the upper casing is close to the outside diameter of the casing being lowered into the underreamed hole. (Figures 1 and 2.)

In such tight wellbores, the casing acts like a piston, forcing wellbore fluids into the formation and preventing the fluids from passing through the annulus. This increases surge pressures on the formation. These surge pressures can exceed the formation's fracture gradient, resulting in severe mud losses and formation damage. The risk of mud losses increases after fracturing the formation, which causes differential sticking and cement-loss problems. The key to relieving the damaging surge pressures is the use of automatic-fill equipment (AFE) that allows drilling fluids to enter the casing while it is being run into the hole (RIH). During one offshore job run in the Gulf of Mexico, Shell Offshore saved $60,000 by using AFE.

AFE EQUIPMENT

The AFE assembly comprises an outer case or collar with holes through which wellbore fluids can freely pass, reducing surge pressures (Figure 3). An internal sliding sleeve of steel or other drillable material is positioned, ensuring that the ports in the collar remain open. After the casing string has been run into the hole, the sliding sleeve can be shifted into the locked position, covering the ports in the outer collar.

Under normal circumstances, conventional floating and guiding equipment fitted with special valves allow wellbore fluids to enter the casing. However, on liners or subsea completions, the casing is run into the hole on the end of a drillpipe. Although the wellbore fluid freely enters the casing through the AFE collar, the restricted ID of the drillpipe still increases the surge pressures on the formation. An AFE diverter can then be used, installed below the drillpipe and just above the top of the liner. Wellbore fluids enter the casing through the AFE collar and exit through the AFE diverter (Figure 4).

AFE ADVANTAGES

In addition to reducing mud losses, the AFE assembly provides casing fill while allowing the required circulation for RIH operations. The AFE is deactivated by pressure rather than flow, allowing operators to use full-bore, casing-cementing plugs to shift internal components. Pressure deactivation also prevents the auto-fill device from prematurely closing during RIH operations.

PERMANENT-SLEEVE DESIGN

The most common AFE assembly includes a permanent sleeve (PS) that maintains pressure integrity between the casing annulus and ID after drillout. The AFE's plug seat and internal sleeve remain open during RIH operations, allowing wellbore fluids to enter the casing. When a cementing plug lands on the AFE plug seat, the retaining pins are sheared, causing the internal sleeve to shift downward and cover the ports in the outer collar. A lock ring holds the sleeve closed , and a lug-and-spline locking mechanism prevents the seat and internal sleeve from rotating. Only the plug seat is drilled out, allowing the internal sleeve to seal the casing ID to maintain casing-pressure integrity.

REMOVABLE-SLEEVE DESIGN

The AFE assembly is also available with a removable sleeve (RS), which is typically used in flushline casing applications where annular clearances are very small. The wrought-aluminum removable sleeve can be drilled out with rock or PDC bits. The entire RS assembly is made from a single-threaded body or case. Like the PS assembly, the internal sleeve of the RS assembly closes the ports in the AFE collar when a cementing plug lands on the AFE plug seat, shearing the retaining pins. The RS design is applicable for situations that do not require casing-pressure integrity after drillout. The removable sleeve

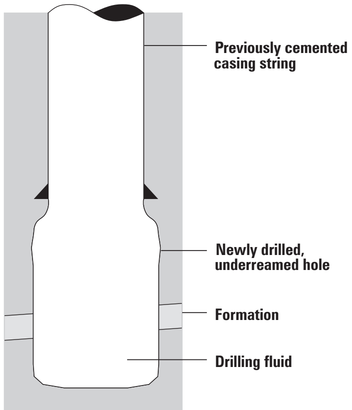

Figure 1: Standard wellbore configuration with an openhole section below the previously cemented casing string. The openhole section is underreamed or enlarged to increase the annular area around subsequent strings. The increased annular area decreases differential sticking of subsequent strings and improves the capability to achieve a good cement job.

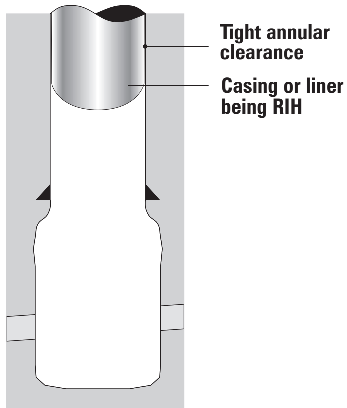

Figure 2: Tight-hole configuration with minimal annular clearance between the casing/liner string being RIH and the previous cemented string. The casing/liner being RIH acts like a piston, forcing fluid below out of the wellbore. The smaller annular clearance prevents fluid flow upward. Therefore, the drilling fluid is forced into—and lost to—the formation.

maintains pressure integrity between the casing annulus and ID before drill-out only.

LINER TIEBACK OPERATIONS

When the shifting pressure of the AFE internal sleeve is increased, the AFE collar can be used for liner tieback (TB) operations. Typically, tieback strings are run with a polished-bore receptacle (PBR) stinger on bottom. The PBR stinger (with seals) is stabbed into the PBR receptacle, providing a seal at the connection of the 2 casing strings. Once a correct fit between the PBR string and the receptacle is obtained, the tieback string with the PBR stinger is withdrawn several feet, allowing cementing operations to be performed. The AFE TB allows cementing operations to be conducted without the PBR stinger having to be withdrawn. Consequently, the risk of damage to the seals on the PBR stinger is minimized.

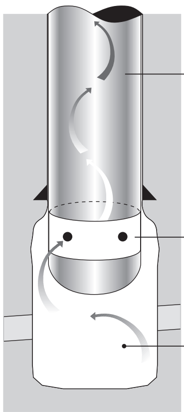

Figure 3: When an AFE collar is attached to the lower end of the casing/liner being RIH, a reliable alternate flow path for the wellbore fluid to enter the casing/liner is created. This flow path allows the wellbore fluids to enter the casing/liner string, resulting is less build-up of surge pressure below the casing/liner. Less surge pressure results in less mud loss and higher running speed while RIH.

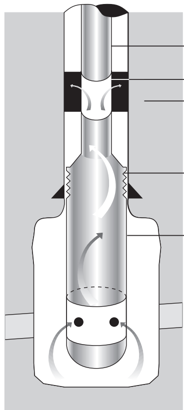

Figure 4: An AFE diverter installed above the liner-running tool provides a flow path for the wellbore fluids that entered the liner through the AFE collar to exit the drillpipe immediately above the liner, eliminating the backpressure created by forcing the fluid to the surface through the drillpipe. Minimizing the overall backpressure as the liner is RIH also minimizes the resulting surge pressures.

CASE HISTORY

Shell Offshore planned to run an 11 ¾-in. liner into a hole located in a zone with typical mud losses of 1,000 bbl per job. Shell needed preventive float equipment that would be useful in a subsea setting while remaining compatible with a hydraulic liner hanger. They decided to use an AFE assembly to reduce formation surge pressures. A sliding sleeve was used to cover the differential fill ports on the collar's body, and the bottom cementing plug was used to close the sleeve after the pipe had reached its total depth. A specially designed equalizer sub and an NR SSR plug set were attached to a slick stringer on the liner-running tool, and the entire assembly was run into the hole during cementing. Overall, Shell Offshore saved $60,000 in additional mud losses.

Introducing an additional flow path above the float shoe complicates cementing and running casing. For example, cement quality near the shoe track will be poor if the side ports are not closed during cement pumping operations, and the actual leakoff depth will be at the side ports rather than at the shoe. Before each job, operational staff must address equipment and operational limitations so that they can most effectively plan the work they will perform.

CONCLUSIONS

Tight wellbores with small annular clearances and operations in which casing is run on the end of a drillpipe place significant surge pressures on the formation. If these pressures exceed the formation's fracture gradient, significant amounts of wellbore fluids can be lost while the casing is being run into the hole. In these situations, conventional floating and guiding equipment do not provide adequate fluid displacement for reducing surge pressures. However, specialized auto-fill equipment allows wellbore fluids to freely enter the casing and exit the drillpipe, effectively reducing surge pressures and preventing expensive mud losses.

ABOUT THE AUTHORS

Anuar Taib *is currently the Lead Drilling Engineer for the Angus Subsea Development Project. He joined* ***Shell Malaysia*** *in 1990 after receiving his BS in mechanical engineering at* ***Case Western Reserve University*** *and was transferred to* ***Shell Offshore Inc*** *in New Orleans in 1997.*

Hank Rogers *is currently the Technology Team Leader for Cementing Casing Equipment. A registered professional engineer, he holds a BS in petroleum engineering technology from* ***Oklahoma State University****. He joined* ***Halliburton Energy Services Inc*** *in 1989.*

Seth Moore *holds a BS in petroleum services engineering technology from* ***Nicholls State University****. He joined* ***Halliburton Energy Services Inc*** *in 1984 and is a technical advisor for business development in New Orleans. He is also the GOM Product Champion for Halliburton's Zone-Seal engineered process.*