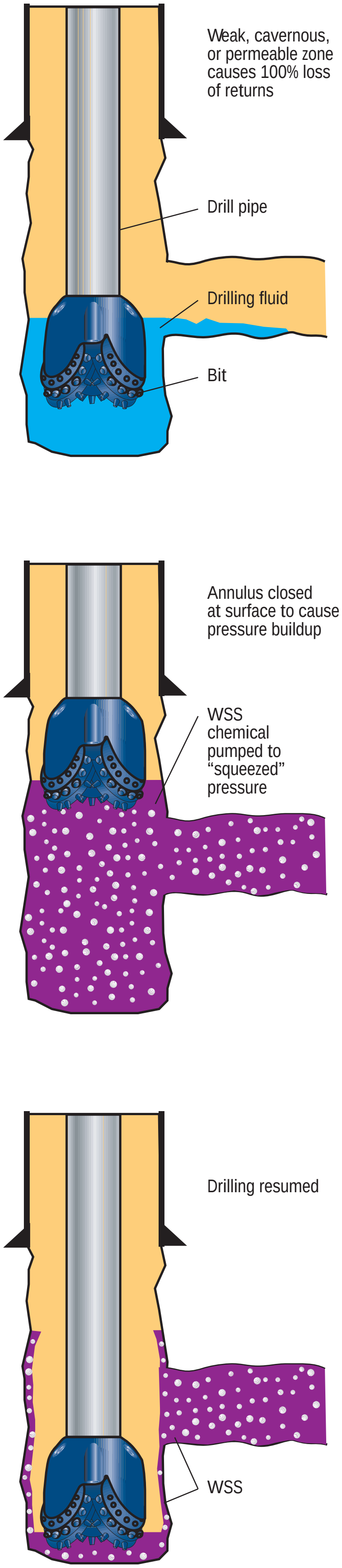
Stabilization system consolidates wellbores



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OPERATORS CAN USE an aliphatic epoxy-based wellbore/formation stabilization system (WSS) to stabilize high-permeability or weak formations to help prevent shear failure. WSS can change a formation’s mechanical properties by increasing tensile strength, Young’s modulus, compressive strength, and fracture gradients. This system can be applied to (1) unconsolidated formations with subsidence problems, (2) lost-circulation zones, and (3) cement-plug operations.

Figure 1 illustrates the application of WSS after lost circulation has occurred during drilling operations. Figure 2 shows WSS being used to support cement in zones where circulation losses are anticipated.

BACKGROUND

High-permeability formations with low tensile strengths are very susceptible to shear failures, and the likelihood of shear failure increases when crossflows exist between zones. These problems are particularly evident in offshore, multiwell completion templates. In these areas, drilling operations can disturb the balancing forces within the formation, resulting in the eventual collapse of cemented casing. When traditional cement slurries are pumped into such formations, the hydrostatic pressure exerted on the wellbore can exceed the formation’s fracture gradient, resulting in loss of cement returns. Even lightweight cements can exert pressure that is too high for some formations. In addition, conventional cement systems cannot completely penetrate the formation matrix and often exhibit high permeabilities. Aromatic epoxy resins, such as those used to seal disposal wells, will penetrate the formation matrix. However, these materials lack ductility and resiliency. In addition, aromatic epoxies are not sufficiently tolerant to aqueous contamination. Contamination by any fluid media will completely alter fluid properties.

WSS SOLUTION

WSS consists of an aliphatic epoxy resin, a hardener, and (for some applications) a bonding agent. This system helps modify formation properties, allowing operators to place conventional cement systems without fracturing the formation or experiencing lost-circulation problems. Before fracturing treatments are performed, small volumes of WSS can be used to help reduce near-wellbore permeability; consequently, fracturing-fluid leakoff can also be reduced in the treated region. After the WSS treatment has been completed, a hydra-jet tool can be used to create a notch at the precise point where fracture initiation is necessary. This notch penetrates the treated region and the untreated formation to help break the formation down and extend the fracture. A successful treatment results in fracture-initiation control and consolidation of the near-wellbore region.

Once the fracture penetrates the reduced-permeability zone, the fracturing fluid will be influenced by the high-permeability formation. As a result, tip-screenout techniques can be used to increase production profiles and reduce sand production, which will help improve overall formation maintenance. In addition, when radial flow patterns are reoriented to form linear flow patterns, changes in drawdown pressure will help increase production levels.

SPECIFICATIONS

WSS is available in low-, mid-, and high-modulus forms for varying formation conditions. The high-modulus form of WSS is generally used for mud/filtercake consolidation in formations with relatively high permeabilities. The low- and mid-modulus forms are used for consolidation in low-permeability formations. In addition, four different resin activators are available for varying temperature applications. WSS can be used at bottomhole circulating temperatures (BHCT) between 40° and 200°F. This system can be pumped as a neat resin, a resin/sand slurry, or barite. It can also be pumped as a dispersion in oil- or water-based drilling fluids. The WSS material will filter out of the mixture to help penetrate and consolidate the formation.

APPLICATIONS

The following paragraphs describe some of the specific applications of WSS.

Figure 1 (left): This shows WSS treatment when lost circulation is encountered during drilling.

FORMATIONS/SUBSIDENCE

In the North Sea, most producing formations contain large amounts of chalk, which tend to flow and cause formation subsidence. As a result, casing can be crushed, choking off production. Foamed Portland cements are often used to cement oil and gas wells in these environments. However, while these cements are resilient and provide high compressive strengths and good insulation properties, they have low densities and high permeabilities. When WSS is combined with a conventional foamer, resulting slurries do not exhibit permeability and can be as light as 6 lb/gal. When used with low-temperature hardeners, foamed or unfoamed WSS can be set at temperatures as low as 40°F.

SUBZONAL ISOLATION

Drilling fluids mixed with WSS can be pumped into lost-circulation zones and allowed to set. WSS can then be pumped through the mud filter cake. Once the filtercake becomes consolidated, the cement job can be run. The consolidated mud filter cake will help prevent the formation of microannuli.

SUBTOP-PLUG APPLICATIONS

Cement plugs are normally set on top of bridge plugs to allow the formation above the plug to be perforated. Before perforation, pressure is applied to the plugs. During this procedure, the casing expands, breaking the bond between the plug and the formation. However, cement plugs formulated with WSS materials can expand with the casing, maintaining the plug-formation bond.

SUBFORMATION MOVEMENT

Foamed Portland cement has high ductility, high tensile strength, and superior bonding properties. When waterborne WSS is added to Portland cement and then foamed, the resulting cement is very resistant to shear failure. This WSS application is useful in areas where tectonic movement disturbs wellbores and causes pipes to collapse.

POTENTIAL APPLICATIONS

In addition to preventing consolidation problems by changing a formation's mechanical properties, WSS has several other potential applications that are currently being investigated.

SUBSLAG CEMENTING

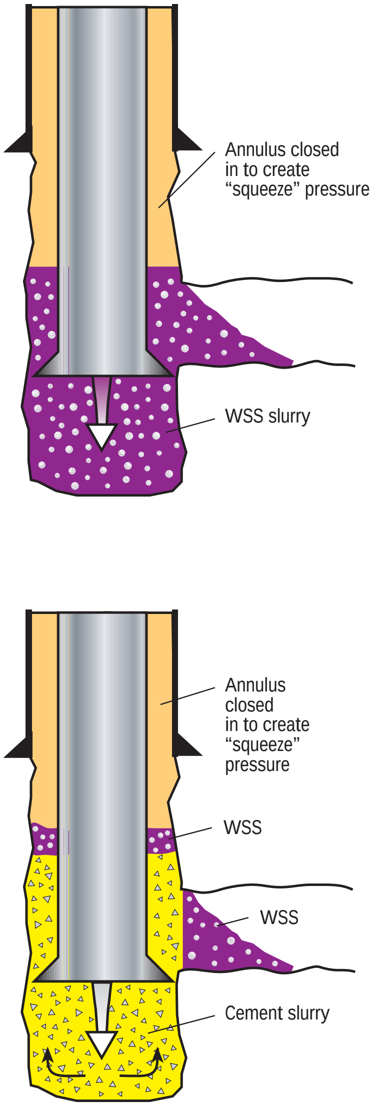

Figure 2: Treatment can be conducted before cementing when lost circulation is anticipated.

Some operators prefer slag cement instead of Portland cement. However, in the presence of alkali, slag cement hydrates and forms hydraulic cement. Even when moist, hydraulic cement exhibits stress cracking that can allow fluid migration. When added to alkali-activated slag, WSS can help prevent this problem.

SUBPIPELINE INSULATION

When WSS is mixed with glass bubbles, it can be used to insulate undersea pipelines. An adequately insulated pipeline has a thermal conductivity of 0.150 Btu/hr-sq ft-°F-ft. Recently, a mixture of WSS and glass bubbles provided a thermal conductivity of 0.102 Btu/hr-sq ft-°F-ft.

CONCLUSION

As energy companies search for hydrocarbons in increasingly harsh environments, new problems with zonal isolation and production continue to occur. These problems can cost operators millions of dollars in repairs and can even force operators to abandon potentially productive wells. WSS can help prevent such incidents by stabilizing unconsolidated wellbores and formations, allowing operators to place conventional cement systems without creating formation fractures or experiencing lost-circulation problems.

ABOUT THE AUTHORS

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