QDRILL IN

Generic System Name: The system is a non-damaging drilling fluid used for reservoir section. Polymer mud with sized calcium carbonate.

Introduction:

Category: Water based drill-in fluid.

Application: Drilling sand and carbonate production zones, horizontal or vertical. Varying rheologies and filtration control properties attainable. System is relatively resistant to anhydrite and salt contamination and can be made inhibitive with the addition of a potassium salt or an amine.

The system is used exclusively for drilling through known reservoir part of the well with the intention of minimizing damage to the rock as much as possible. Therefore, it is essential to select the right size and amount of calcium carbonate / acid degradable weighing agent to be used. This is a specially devised system exclusively used for drilling through reservoir to ensure that formation damage is minimized as much as possible.

Replacement for: Other bridging drill-in fluids (i.e. salt saturated polymer system, resin polymer system, cellulosic fiber polymer system). The choice of fluid will be dictated by formation damage mechanism.

Key aspects

- Designed for drilling the reservoir
- Skin damage is minimized
- Filter cake is easily removable
- Easy to maintain

Components: QDRILL IN

QMax Product	Function
Water	Continuous phase
**QXAN*	Viscosifier
**QPAC LV*	Fluid loss control
**QSTAR ENV / HT*	Fluid loss control
Calcium carbonate	Acid soluble bridging
Caustic Soda	Alkalinity control
**QCIDE*	Bactericide

* Proprietary or brand name products

Use of MAXSITE QSEAL software will give the optimum concentration and amount of calcium carbonate and other bridging agents to add to the system and obtain the best sealing properties.

Key aspects

- Avoid using surfactants
- Use MAXSITE QSEAL software for $CaCO_3$
- Use acid soluble weighting agents
- Do not use PHPA / MAXCAP D

Typical System Properties

QDRILL IN		
Property	***Range***	***Min/Max Recommended***
Mud Weight, ppg (kg/m³)	8.7 - 9.2 (1040 - 1100)	<9.6 (< 1150)
Plastic Viscosity, cP	15 - 35	< 40
Yield Point, lb/100ft² (Pa)	12 - 30 (6 - 15)	<50 (< 25)
Gels, lb/100ft² (Pa) 10"/10'	3 - 10 / 16 - 25 (2 - 5 / 8 - 13)	As required
pH	9.0 - 10.0	< 10.5
Calcium, mg/L	40 - 200	< 200
MBT, ppb-eq (kg/m³)	0 - 5, 0 - 14	<10 (< 30)
API Fluid Loss, cc/30min	4 - 8	< 8

Key aspects

- Avoid using barite for mud density
- Maintain low MBT
- Monitor PPT
- Maintain desired PSD

Field Operations

Mixing Procedures

For New System: Start with clean tanks and fresh water. Reduce calcium content to below 200 mg/L with soda ash. Mix required viscosifier, fluid loss additives and the rest of components to desired properties. Add caustic soda to achieve required pH. A Yield Point above 10 lb/100 ft^2 (5 Pa) is recommend before adding bridging agents to insure it stays in suspension. Circulate system to homogenize the concentrations. Recommend to drill out cement with water and viscosified sweeps from a short circulating system.

For mix “on the fly”: Not recommended

Maintaining Properties

Daily additions of calcium carbonate required to maintain proper particle size distribution if make-up or dilution water added. An increase in additions of the larger sized calcium carbonate will account for some particle attrition that occurs at the bit and while circulating through the whole system. Pre-mixes should be made with programmed or elevated product concentrations.

Slugs or sweeps should incorporate the same ratio of sized calcium carbonates as the original formulation or a slight increase in the larger sized product for reason stated above.

Diligent monitoring and maintenance of pH required. It is important that some hydroxide is evident in the alkalinity analysis to help keep the system stable and reduce bacterial contamination.

Maintaining correct doses of bridging calcium carbonate is very essential to build impermeable filter cake and arrest fluid invasion to minimum extent. Regular replenishment doses are necessary to account for attrition of solids as well as their discarding through shaker screens.

Fluid Specific Tests and Equipment

- Complete WBM testing kit.

- Brookfield Rheometer if required.
- PPT Testing Kit
- Portable PSA
- Samples sent to the lab for PSD analysis can confirm proper calcium carbonate additions to achieve programmed concentrations in case there is no availability of a portable PSA.

Contaminants: effect and treatment

Contaminant	Mud Effect	Treatment
Aeration	Pump jacking	Defoamer, eliminate air sources.
Bacteria	Filtration increase; pH drop; carbs/bicarbs increase; odour; aeration; viscosity drop	Bactericide and pH to 10.0 minimum
Calcium	NA - if MBT low; if > 400 mg/L reduced polymer hydration	Reduce with additions of soda ash
Cement	Rheology change, increase pH and Ca^{++}	Sodium bicarbonate, citric or Sulfamic Acid
Surfactant	Foaming	Prevention from cement water and rig wash; Antifoam agents premixed in the makeup water and/or defoamers
CO_3^{2-}/HCO_3^-/CO_2	No OH^- in alkalinity analysis	Caustic soda, lime
H_2S	Odour, corrosion	Zinc carbonate, zinc chelate, scavenging amine, pH>10.0
LGS	High PV and pump pressures	Inherent in system due to concentration of calcium carbonate
Salt	Increased Cl^-	Dilution, live with the effects or convert to a salt system
Water influx	Dilution	Replenish to recommended levels, density increase may be required to stop flow

Operational Recommendations and "Best Practices"

- If system used for drill-out, pre-treat with sodium bicarbonate and citric acid to reduce pH below 10.5, to lessen polymer degradation by hydrolysis.
- Run bacteria tests continuously and have two bactericides on stand-by. Switch between them on treatments.
- If torque and drag encountered, run liquid lubricants (i.e. QLUBE at 3% v/v). Consider formation damage and disposal options before doing so.
- If makeup water unsuitable due to bacteria, pre-treat with bleach.
- Recommend drill out cement with previous mud system and isolate.
- System is easier to maintain with "proactive" measures such as daily maintenance regime. Concentrated pre-mixes for maintaining or manipulating properties an option.
- Run LGS as low as possible to prevent increase in rheology.
- If the application requires corrosion inhibitors (e.g. QTDL-15), the simultaneous addition of defoamer reduces foaming.
- Diligently maintain mud weight and as far as possible derive mud weight number with the help of geo-mechanical modelling to know the correct value to drill with.