QVERT

Generic System Name: Oil-based drilling fluid system containing conventional diesel as base oil and calcium chloride as brine.

Introduction:

Category: Oil-based drilling fluid system.

Application: The QVERT system is applicable where highly reactive formations are present and there are no environmental restrictions for the use of OBM. The QVERT mud system allows drilling through troublesome shale without interfering with the internal structure of the rock provided it has the correct salinity to avoid movement of water from the mud to the shale. It has very good lubrication properties which makes it ideal for drilling wells with complicated geometries and extended reach. When there are significantly different formation pressures in a single interval, QVERT minimizes the risk of differential sticking. It can be used to drill with a mud density below the water gradient and also it is recommended to be used when high densities and temperatures are expected. Off-shore in shallow applications where it is necessary to provide borehole stability across water sensitive shale. The capillary pressures, convex meniscus in capillaries and osmosis are responsible for the shale inhibition resulting in excellent borehole stability and the retrieval of un-dispersed cuttings.

Oil-base fluids allow the drilling of reactive formations more efficiently than water-base fluids. Soft shales can be controlled or hardened by exposure to oil-base fluids which have high-salinity water in the emulsified phase. Transfer of water from the shale to the oil-base fluid is attributed to osmotic forces across the semi-permeable membrane around the emulsified water droplets.

Replacement for: HPWBM; other inhibitive water based muds

Key aspects

- Used for drilling troublesome shales
- Excellent hole stability
- Easy to maintain
- Can be recycled and re-used

Components: QVERT system

QMax Product	Function
Conventional Diesel	Continuous phase
Calcium Chloride brine	Internal phase
**QMUL I*	Primary Emulsifier
**QMUL II*	Secondary Emulsifier
**QMUL GEL*	Viscosifier
** QTROL*	HTHP filtrate reducer
**QWET*	Wetting agent
Hydrated Lime	Alkalinity control

* Proprietary or brand name products

Key aspects

- Mixing order and shear are critical
- Lime is key for emulsion stability
- Use QWET when densifying active system
- When possible, add prehydrated lime

Typical System Properties

QVERT		
Property	***Range***	***Min/Max Recommended***
Mud Weight, ppb (kg/m^3)	7.2 - 17.5 (860 - 2,100)	<15.6 (< 1,900)
Plastic Viscosity – cP	5 – 35	< 40
Yield Point, lb/100ft^2 (Pa)	8 – 30 (4 – 15)	<50 (< 25)
Gels, lb/100ft^2 (Pa)	2/16 - 10/24 (1/8 - 5/12)	As required
Lime excess, ppb (kg/m^3)	2 - 6.5 (6 - 18)	>3.5 (> 10)
Electrical Stability, Volts	600 - 1,000	> 600
HTHP Fluid Loss - cc/30min	4.0 - 8.0	5.0 – NC
LSYP, lb/100ft^2 (Pa)	6 - 12 (3 - 6)	>12 (> 6) in deviated sections
Water Phase Salinity, mg/L	200K - 350K	As required
Oil/Water ratio (OWR)	75/25 - 95/5	> 60/40

Key aspects

- Low temperature will increase rheology
- Alkalinity should always be monitored
- Water in filtrate is a sign weak emulsion
- If possible, monitor cuttings activity

Field Operations

Mixing Procedures

For New System: QVERT is normally supplied as a pre-built system at the rig-site. If the supplied fluids' properties are lower than specifications, shear through the bit and addition of extra products will bring properties on line. Mixing QVERT on location is possible. The recommended procedure is listed below:

1. Ensure tanks and lines are clean and free of water.
2. Measure the appropriate amount of base fluid into the mixing tank and circulate the oil through the hopper and fluid guns. Work with the agitators. QVERT stability depends on shear.
3. Add QMUL I and Lime (5-10 min/sk) together through the hopper to the base oil.
4. Prepare the brine in a different tank and add it slowly through the hopper ($CaCl_2$ - 90% purity).
5. Add the QMUL GEL at 5-10 min/sk. Organophillic clay needs a good deal of shear (preferably through the bit) and time to yield.
6. Add the QMUL II next.
7. Add the appropriate amount of QTROL through the hopper and allow mixing for a minimum of 45 minutes.
8. Add proper amount of weight material to attain desired fluid weight. To insure proper wetting and dispersion, slow the additions of weight material as fluid weight increases. Periodically during weight-up, check yield point, gels, and emulsion stability to insure proper barite suspension and that a stable emulsion is being formed. Slower additions of weight material may be necessary if inadequate shear exists and emulsion stability is not stable or is decreasing. An addition of wetting agent should be considered.

Note: If the brine water has to be made in the mixing plant by adding sacked salt to water, this would become the first step.

For mix “on the fly”: Not recommended

Maintaining Properties

Minimum of two circulations usually required before change in properties noted after product addition. Daily maintenance regime is best option to maintain properties. Concentrated pre-mix addition is alternate option to maintain or manipulate properties.

Maintenance of the system will depend upon the properties desired. Whether density changes, rheological control, emulsion stability, etc are the key to drilling ahead, logging, etc., the properties of the QVERT system can be readily modified as needed.

Additions of wetting agent or secondary emulsifier are very important when adding any solid additive, especially weighting material such as barite or calcium carbonate. Control alkalinity of aqueous phase by adding lime in order to have an excess lime of 15 kg/m^3 to be prepared for a gas kick. The stability of the shale depends greatly on the salinity of the aqueous phase, so it is important to match the salinity of the mud with the salinity of the rock. This can be done by measuring the water activity onsite with a Hygrometer, then, mud engineer can adjust the salinity to the desired value.

When possible, use concentrated brine to increase water phase salinity.

To achieve optimum economics when using emulsifiers and changing oil content, as well as to minimize the plastic viscosity of the fluid, the oil/water ratio is varied with the fluid density. As drilling commences, drill solids accumulation and increases in fluid density requires increased additions of emulsifiers and wetting agents. Water breakout and/or HT/HP increases are direct indicators that additional emulsifiers/wetting agents are required. It is recommended that the HT/HP checks be run every eight hours so that a trend can be developed. Any increases in HT/HP filtrate or detections of water in the filtrate must be treated immediately.

Fluid Specific Tests and Equipment

- Complete OBM testing kit
- May require Hygrometer to test shale activity
- Garrett Gas Train for possible H_2S monitoring

Contaminants: effect and treatment

Contaminant	Mud Effect	Treatment
Aeration	NA	NA
Bacteria	NA	NA
Calcium	NA	NA
Cement	NA	NA
CO_3^{2-}/HCO_3^-/CO_2	Lower alkalinity	Lime
H_2S	Lower alkalinity; surface release	Lime, HSO 600 (amine scavenger)
LGS	High PV's; torque & drag	Centrifuge and / or dilution
Salt	Chloride increase	NA
Water influx	Reduces oil water ratio; affects rheology; decreases salinity and ES	Increase density; add base, $CaCl_2$, emulsifiers and wetting agents

Operational Recommendations and "Best Practices"

- For offshore applications, use brine, viscosified brine or viscosified seawater spacer ahead of OBM for initial and riser displacements. Dyed spacers are easier to distinguish at shakers.
- Screen down after trips due to cold, inactive mud.
- System is easier to maintain with "proactive" measures of daily maintenance or concentrated pre-mix additions.
- Pilot test before additions of thinners and low end rheology modifiers.
- Closely monitor LSRV in deviated sections in case of unexpected extended periods without circulation to reduce effects of barite sag.

- Do not “over-treat” to rapidly acquire target properties.
- Analysis of cuttings shape, size, amount and integrity paramount to wellbore stability, proper inhibition, density and hole cleaning.
- Tanks, lines and pumps cleanliness paramount to successful clean-up before completion operations. Clean-up schedule should include instructions for the cleaning of all mentioned equipment.
- Cuttings segregation for disposal.
- Heated storage for the QMULs and QWET in the winter is recommended, especially if the concentrated products are used.
- Cover mud pits to avoid the entrance of raining water into the QVERT mud system.
- Recommend to have all the mud tanks area surrounded by ditches to be able to react in case of a spill.
- Have on standby, LCM pills or Kill mud if expected mud losses / high pressures. Reaction time is important in these cases.
- Storage of liquid additives must comply with Operator and local regulations.