# Environmentally Safe Water Based Mud Replaces Invert Oil Muds For Shale Gas Exploration

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## What is an "invert oil mud"?

The term "invert" indicates the mud is a water-in-oil emulsion mud. The oil is the continuous or major phase and water is the minor phase. The oil typically used in invert oil muds is diesel, distillate or synthetic hydrocarbons. The oil concentration ranges from 50% up to over 95% by volume.

## Why are invert oil muds used in shale gas exploration?

The preference stems from the belief that oil muds generally provide greater shale stability in the wellbore, and offer lower coefficient of friction, improving rate of penetration. Shales can exhibit a high degree of water sensitivity leading to swelling or disintegration. Either action can lead to problems in drilling.

**Key Points**

- Drilling muds are evolving to meet environmental requirements.
- Drilling + Environmental performance are required for drilling muds to be considered effective.
- Shale gas formations present new challenges to traditional drilling muds.
- Biodegradable, clean, high performance drilling muds are meeting the challenge.

## What is water - based drilling mud?

Just as the name describes, water-based muds (WBM) are typically clay-based, water muds where the water is the major or continuous phase. WBM's without treatment are not acceptable for drilling into water-sensitive shale formations. The WBM's can be treated with oil-based additives to improve the rate of penetration and lessen the penetration of water into shale formations. WBM's can also be treated with medium to high molecular weight polymers of various chemistries to form a protective layer around shale, preventing disintegration of cuttings.

## Barite : Weighting Material

The common weighting material today in drilling muds in either OBM, SOBM, and WBM is barite. The barite (or barium sulfate) is mined from special rock formations as a raw ore. This raw ore is then ground to a face powder consistency for use in drilling muds. Drilling muds weighted with barite can weigh over 18 pounds per gallon. The particles of barite are suspended in the liquid mud by the adjusting the mud's viscosity profile.

## Synthetic oil versus diesel or distillate.

Synthetic oils arrived on the drilling fluid scene in the mid-1980's as environmental pressure mounted against the discharge of diesel or distillate based drilling mud into the environment. Synthetics oil muds are made by blending water into liquid synthetic hydrocarbons made from a known chemical starting point as opposed diesel or distillates which are simply crude oil refined products.

  

They include olefins oligomers such as: polyalphaolefin and isomerized alpha olefins, which start off as ethylene gas. Esters are made from vegetable oils by reacting the oil with methanol or higher alcohols. Paraffinic hydrocarbons are also considered synthetic although they are more a product of crude refining and hydrogenation than synthetic starting point development. Considerable volumes of diesel are still used to manufacture drilling muds. The handling and disposal of the diesel drilling mud and drill cuttings are generally more costly to deal with than synthetic oil muds. However, in many regions synthetic oil muds face strict controls as well.

## What are polymer muds?

Polymer muds as their name implies are water-based muds containing one or more polymeric materials. The polymers are generally high molecular weight acrylic materials capable of creating a highly viscous water solution sufficient to suspend weighting materials and other solids used as functional additives in drilling muds such as loss circulation additives. The characteristics and types of polymers potentially used to build polymer muds are numerous.

When polymer muds are used to drill through a highly reactive shale it is common for the polymers muds to be treated with a salt such as potassium chloride (KCl). The addition of KCl provides a beneficial concentration of potassium ion into the mud helping to minimize shale hydration.

## What are the real drawbacks to using oil based muds?

The oil muds produced with diesel or distillate are coming under attack by health organizations due to the possible exposure of oil rig workers to dangerous levels of hazardous compounds such as: naphthalene, benzene, toluene and other aromatic hydrocarbons. The reports indicate the exposure levels of these compounds are above acceptable levels for oil rig workers.

While synthetic oil muds lack the presence of hazardous compounds, as is the case with diesel or distillate, they present a different challenge for drilling companies. Synthetic drilling muds contain high concentration levels of chemical additives to help create and stabilize the emulsion needed for synthetic muds to function. Many times these chemical additives contain elevated levels of environmentally harmful compounds.

The synthetic oil muds may also contain elevated levels of chloride salts. The chloride salts provide an emulsion stabilizing effect as well as added shale inhibition.

  

The drill cuttings (the earth material removed from the well bore during the drilling process) are completely coated with a tenacious layer of oil-wet solids and synthetic oil. This requires all cuttings be handled as oily waste and disposed of in proper disposal sites at a considerable cost to the operator.

During and following the completion of drilling operations, all surface equipment exposed to synthetic drilling muds must be completely and thoroughly decontaminated before the drilling rig is relocated. This cleaning procedure can take several days to complete using high pressure steam cleaners and detergents. All of the waste water generated from cleaning operations, as well as runoff collected on site during the drilling process plus any waste residue must be contained, manifested, and properly disposed according to local, state and federal guidelines.

## Why not use water-based muds for shale gas exploration?

Many operators have attempted to use traditional water-based muds with limited success and mixed results. Given gas shale exploration requires first drilling a vertical section, then building a high degree angle, and finally a horizontal lateral section of several thousand feet in length, water-based muds have generally failed to provide reliable performance to meet such drilling requirements.

Highly treated water-based muds have shown marginally better results, but over time operators have returned to the proven performance of oil and synthetic oil based muds. The combination of a high degree of shale inhibition coupled with the improved lubricity characteristics make oil muds the preferred fluid.

## Is there a water-based alternative to oil based mud for gas shale drilling?

**Yes.** There is now a new type of water-based drilling mud developed specifically for gas shale exploration. The new water-based drilling mud incorporates several new (patent-pending) approaches to building effective drilling muds.

Unlike the traditional water-based muds of the past, the new hybrid water-based mud commercially identified as the "Quantum EF" drilling fluid, developed by Rapid Energy Services, LLC, uses a totally new and innovative approach to building a water based drilling mud. The Quantum EF drilling fluid is referred to often as a "hybrid" water-based drilling mud. It incorporates the highly lubricating characteristics of certain plant-derived oils along with the shale-inhibiting characteristics of a (patent-pending) surfactant

  

combination. The two combine to form a highly stable oil-in-water emulsion. The water phase portion of Quantum EF is contains a non-chloride potassium salt to provide additional shale stability within the water phase.

## Quantum EF : A "Cleaner" Mud

The Quantum EF is also referred to as a "clean" mud based upon how easy it is to remove from surface equipment. The word "clean" and drilling mud normally do not go into the same sentence. However, with Quantum EF, rig workers often comment on just how easy it is to remove the drilling mud from tools, rig surface, and exposed skin surfaces. All of the ingredients incorporated into the Quantum EF drilling mud are considered safe for oil rig workers. The Quantum EF contains no aromatic or diesel oil range organics. Tested by independent laboratory the Quantum EF reports a greater than 90% biodegradable carbon in the active (non-water) portion of the drilling mud.

The fact that Quantum EF is so easily cleaned from surfaces saves drilling operations potentially several days of down time by greatly reducing the cleaning stage in rig relocation operations.

More important than rig cleanliness is how Quantum EF is easily rinsed from drill cuttings. By simply arranging a water rinse spray bar over the shale shakers the cuttings are easily rinsed free of any residual. The result is clean cuttings. We cannot predict the disposition of cuttings in advance given the many different regulatory agencies involved. However, we can say that the cuttings will lack any real residual volume.

## How does Quantum EF clean up downhole?

Using an easy-to-clean drilling fluid is really a secondary consideration for most operators in selecting a proper fluid. Exploration managers also ask, "will the drilling fluid affect the production performance of the well?", an important consideration. We know through return permeability laboratory testing using formation cores just how reliable Quantum EF is in achieving a high gas flow back value. The results are clear on how well Quantum EF is removed from formations and does not impair or interfere with the flow of gas from the formation. In testing it is reported core samples treated with Quantum EF demonstrate higher than normal flow back of fluids. In contrast, the same cores exposed to oil based muds reported a measurable decline if flow back of fluids, indicating well

  

performance may be compromised by exposure to drilling fluid.

### Does Quantum EF require any special testing or engineering considerations?

In general the Quantum EF is handled in the same manner as a water-based mud. The functional ingredients are inventoried at the job and added periodically based upon routine mud analysis at the rig. Unlike in a traditional mud, where oil or water content measurements use a thermal retort device, Quantum EF's stable emulsion resists separation rendering this method inadequate. The preferred method to measure the water content (and therefore the non-water content) is by use of a Karl-Fischer apparatus (KF). The KF apparatus is a common lab device that is easily adapted to field use to provide mud engineers with a tool to analyze Quantum EF's in-field physical properties.

The Quantum EF operating guide book provides all of the information needed to properly apply the drilling mud in the field as well as 24/7/365 technical support team ready to handle any issues.

### How is Quantum EF supplied to the drilling rig?

Quantum EF, unlike a traditional water based mud is handled in a similar manner to any oil based mud (diesel or synthetic) in so far as it is supplied in a system rental manner. The reason for this is simply because the value of the product for repeated applications. When using a traditional water based mud, the end of job normally sees the mud going to disposal or to a liquid mud company for little to no value. In the case of Quantum EF the mud is simply reconditioned by reducing low gravity solids, adjusting density, and replenishing key emulsifier and other ingredients. At this point the Quantum EF is ready to drill another project.

### How does Quantum EF's price compare to other water-based muds, diesel oil muds, and synthetic oil muds?

The per barrel price of a Quantum EF system after adjusting for density is similar to diesel oil based mud, lower than synthetic oil based mud. Operating region can affect this determination upward or downward. When compared across the board, the Quantum EF is generally less than its equivalent counterpart oil based drilling mud, and higher than water based muds. Comparisons to water based muds are generally not a fair comparison for many reasons. Water based muds are generally not used in the same drilling environment as you would find use of Quantum EF drilling mud. Therefore Quantum EF shows up as more economical per barrel.

The real savings for Quantum EF go way beyond the per barrel savings. The combination of a high rate of penetration, gauged hole, and easier clean up after job is over, make using Quantum EF a cost-saving opportunity. The clean cuttings are potential savings if the region allows for clean cuttings to remain on location following the relocation of the drilling rig.

  