AADE Houston Chapter
Fluids Management Group

Oil base drilling fluid compatible
gravel packing

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This could be your well

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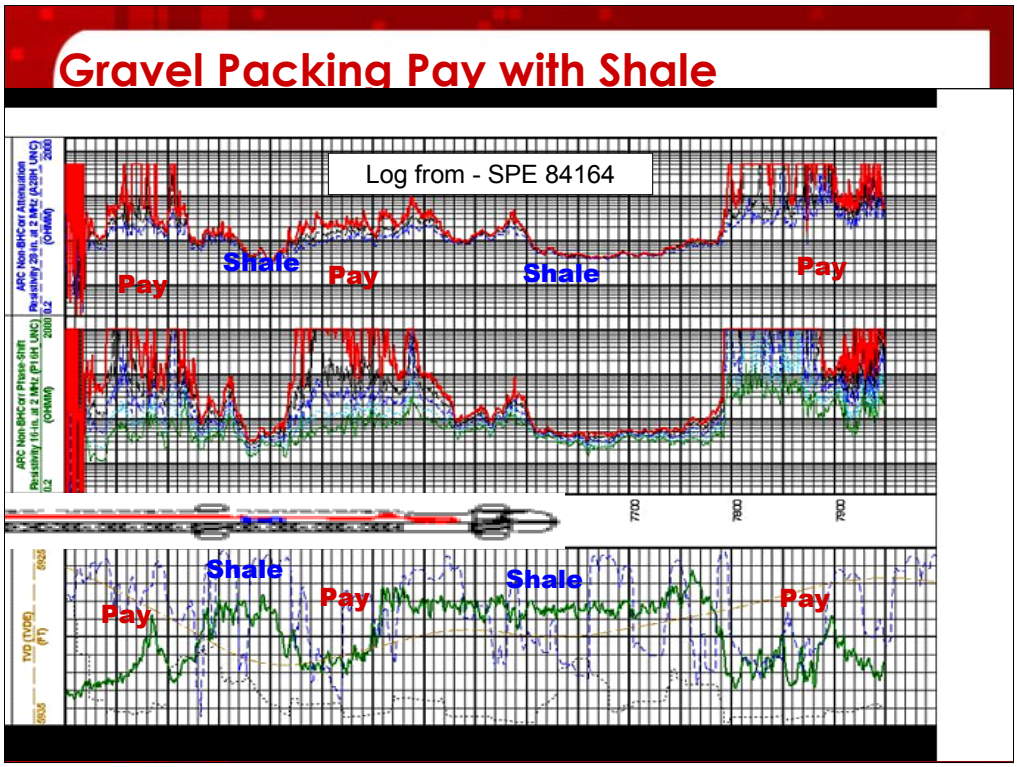
Suppose you were drilling a well here and your reservoir model and reserves recovery plan determined that a open hole horizontal gravel pack was the best completion choice.

No, this is not in Louisiana.

Your drilling engineer shows you this picture of the stabilizers used when the previous well's lateral was drilled with water based drill-in fluid. Does Anyone know what that is? Answer – It's active, unstable shale drilled in the open hole pay zone of a well gravel packed in Nigeria.

This is the type of active, unstable shale that can cause hole problems when exposed to water based fluids. Shale swelling and sloughing can cause gravel pack screen assemblies to become stuck so that part or all of the pay zone can't be completed. Or the screen installation may be accomplished but partial hole collapse may cause the gravel pack to be incomplete leaving bare screen exposed during production. There may be no indication of problems until the producing well starts losing production rate or starts making sand.



This is the log from that last lateral. In this example well, the active shale was exposed to water base fluid, first drill-in fluid and then the completion fluid used to prepare the well for gravel packing during –

- drilling of the lateral open hole pay interval

- circulation and filtration procedures used to swap the well to filtered completion brine

- time required to make up and run in the screen, washpipe and gravel pack assembly.

In this imaginary well the shale was exposed to water base fluids long enough that when the screen was run into the open hole, it became stuck and could not be run past the second longer shale interval. In real instances in other wells in this field, screens did get stuck. As a result, the gravel pack completion turned into a stand alone screen. Stand alone screen completions in this field have a history of reduced production efficiency (compared to the gravel packed wells) and also have a history of sand production to the point of causing the well to be shut in.

So what are you going to do on the next well?


Harvey Fitzpatrick
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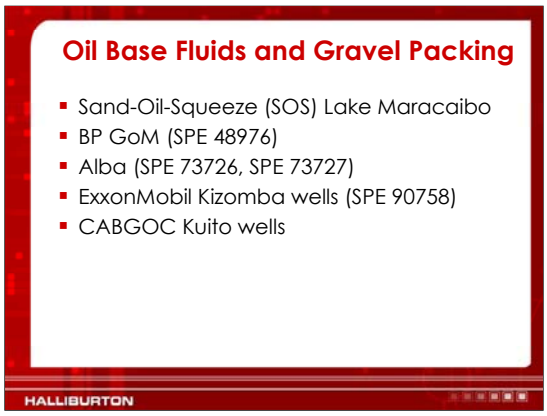


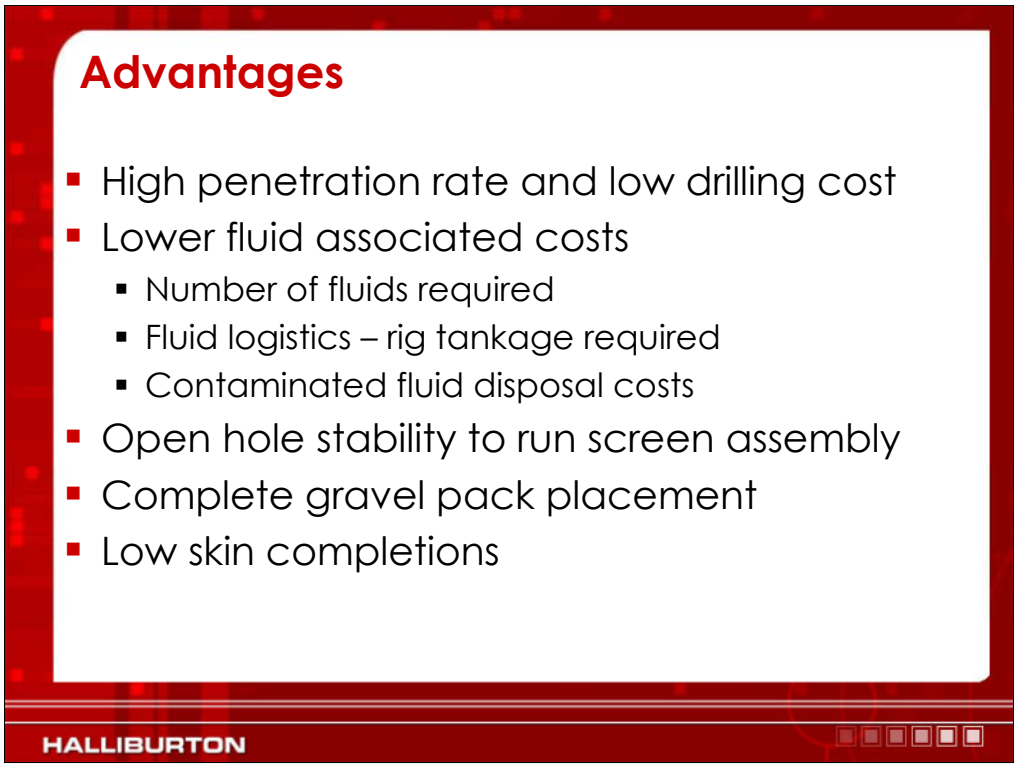
To mention just a few examples -

SOS – Shell and others in Lake Maracaibo Venezuela started as early as the 1960's. This process used oil for the gravel carrier fluid.

BP GoM reservoir had reactive shales – drill with SBM. Testing – compatibility for displacement, SBM filter cake flow back, run PDL, displace to brine

ChevronTexaco evolved a procedure using OBDF and displacement to water base fluid for gravel packing. SPE 73726 and 73727

XOM SPE 90758



high penetration rate and low drilling cost provided by non-aqueous drilling fluid

hole stability provided by oil based fluid and shorter water base fluid exposure - running screens in oil base fluid and swapped to water base fluid just prior to gravel packing.

- Improved oil base – water base fluid compatibility for clean fluids interface

efficient displacement of non-aqueous fluid from the open hole pay interval without fluid compatibility upsets

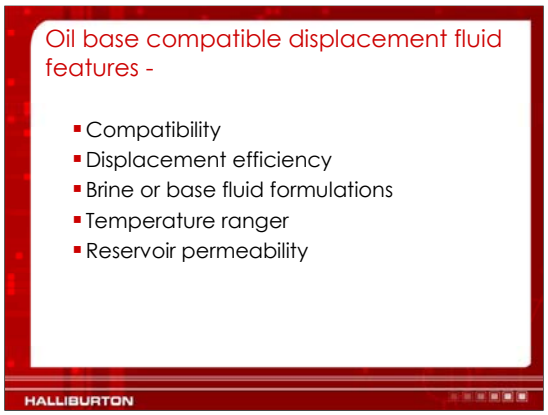
reduced fluid waste and disposal

more efficient drill-in fluid displacement enables more complete gravel fill

Reduced fluids residue to maintain screen and gravel flow capacity and reduced drill-in fluid residue plugging.

-integrity of the non-aqueous fluid wall cake is maintained to enable return circulation for gravel packing.

-For one major operator, implementing the OCDF fluid and tool system has resulted in successfully running screens to TD on 17 consecutive wells involving oil-based fluid to water-based fluid displacement procedures. Previous screen placement success rate was only 57%. The OCDF system has been used in wells up to 4,700m TD, hole angles up to 86° and openhole lengths of 750m. (See SPE 90758.)

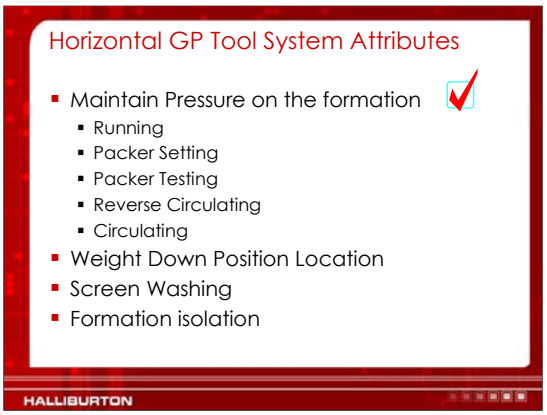


Additive package tuned for compatibility with the oil based drill-in fluid, the formation fluids and formation mineralogy.

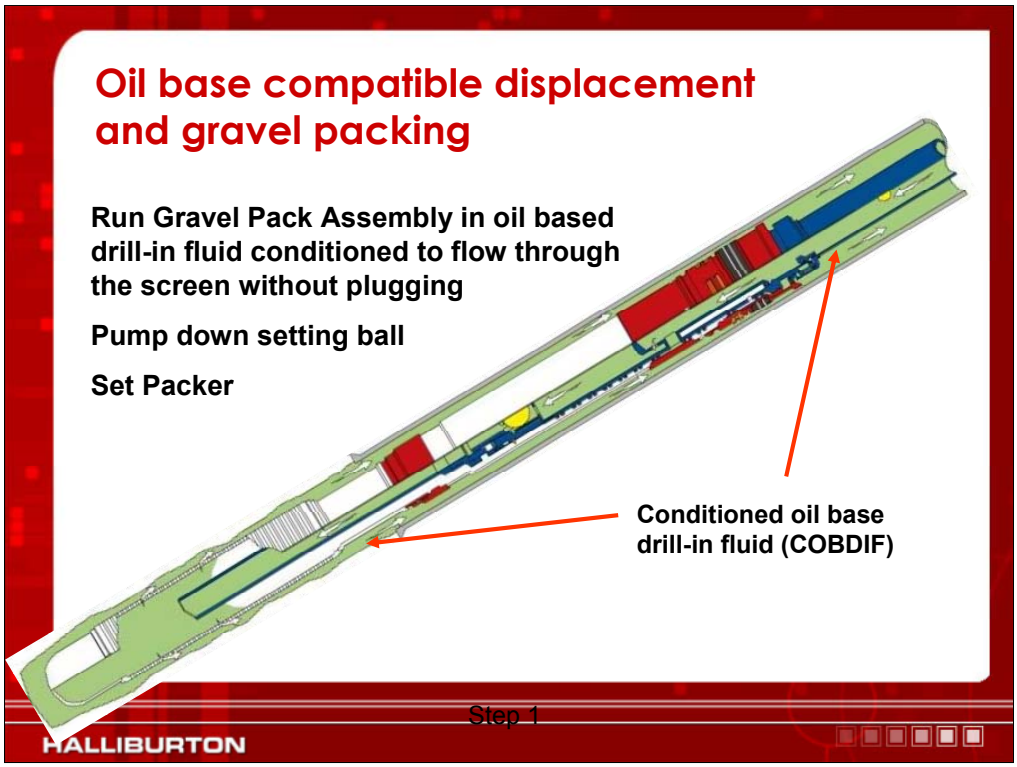
Formulations can be mixed with fresh water, sea water, NaCl, KCl, NaBr or combinations of salts to meet fluid density and formation compatibility requirements.

Usable at reservoir temperatures in the range of 115 to 230 °F.

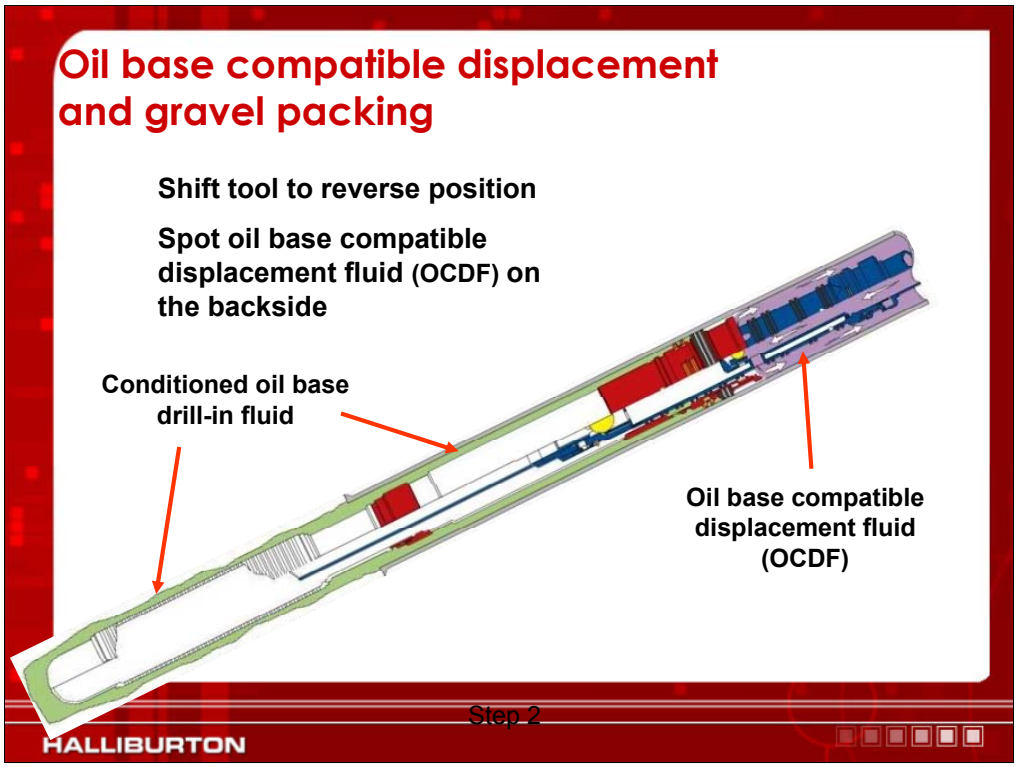
Testing with formation cores from a deep water reservoir gave over 80% retained permeability.



Positive Hydrostatic pressure must be maintained to preserve OBF filter cake integrity throughout each step of the gravel packing process.

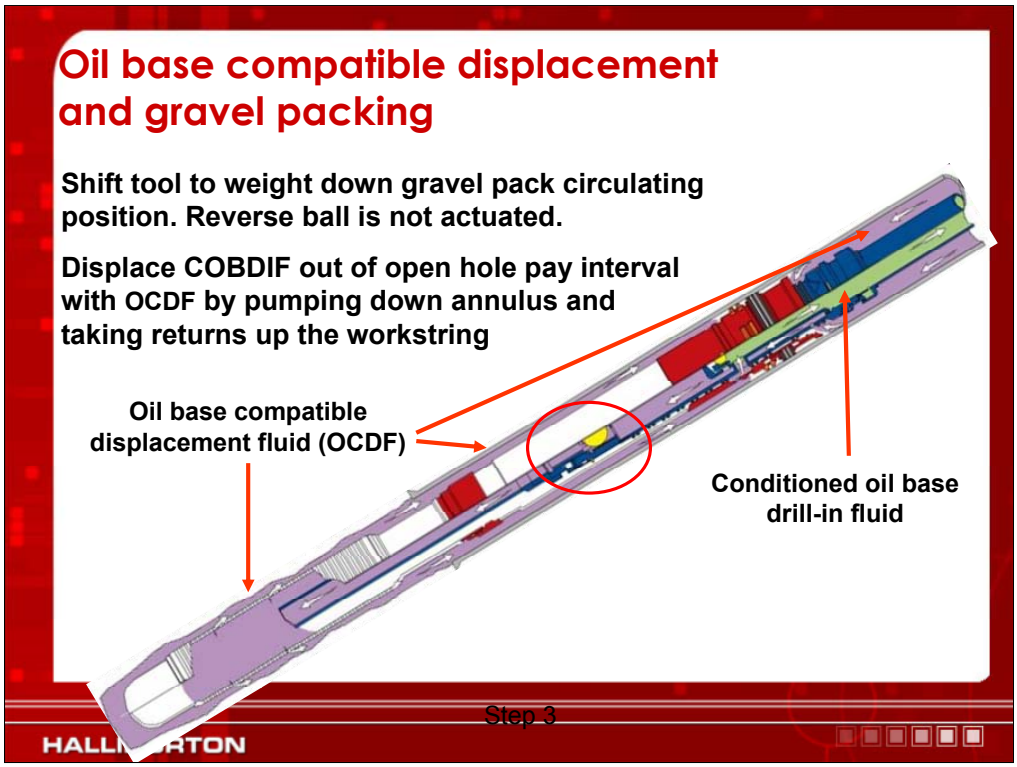


Before running GP assembly, the oil base drill-in fluid is conditioned using solids control equipment and shaker screens sized to reduce solids size so that whole drill-in fluid is able to flow through the screen without plugging it. This is referred to as conditioned oil base drill-in fluid (COBDIF).



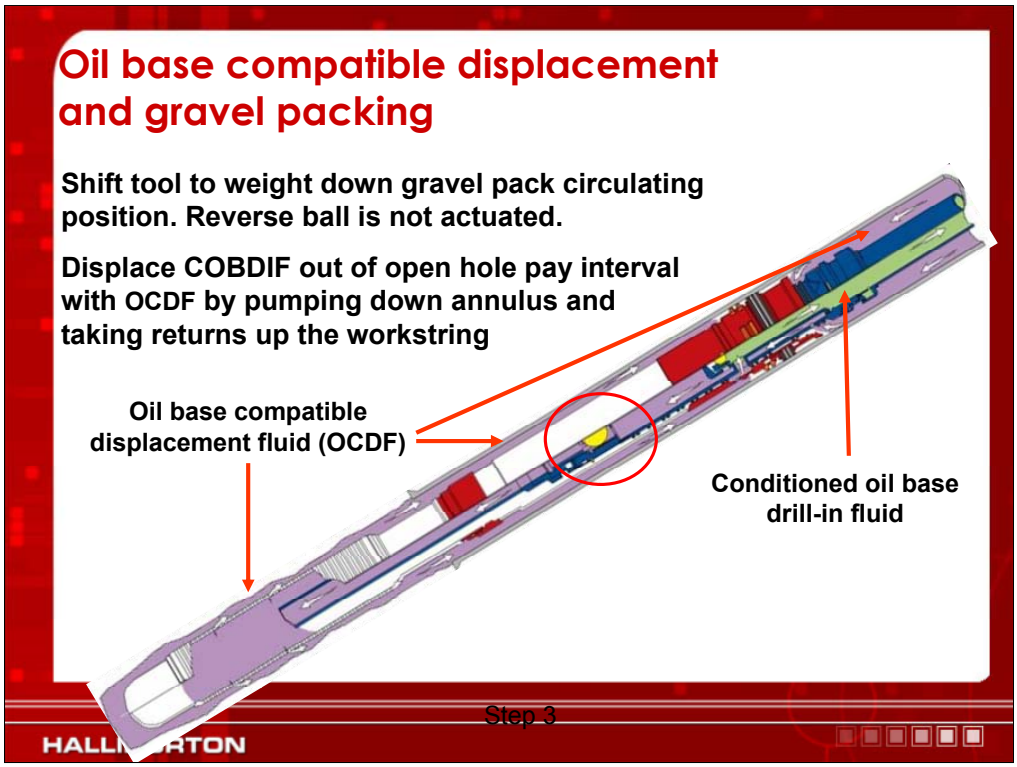
Shift tool to reverse position. Do not actuate the reverse ball check.

Spot a minimum of two open hole volumes plus additional volume for spacer pads left in workstring and before displacement and in the annulus after displacement of the open hole.



Conditioned oil base drill-in fluid is pumped down the workstring – casing annulus to push the OCDF displacement fluid out of the annulus above the packer.

The reverse ball check is not actuated / on seat so it is possible to circulate fluid from the workstring – casing annulus backwards through the returns path of the gravel pack service tool. The OCDF oil base compatible displacement fluid then flows down the washpipe, out the screen into the open hole x screen annulus, then up the annulus, into the gravel pack treating port of the service tool and then up the workstring. This flow path is the exact opposite of the fluid path normally taken during the pumping of a circulating gravel pack. It is made possible by the actuated reverse ball check which does not seat and seal as a check valve until it is actuated after the gravel pack is pumped. The conditioned oil base drill-in fluid is displaced from the open hole into the workstring. Now the water base OCDF displacement fluid is filling the open hole.



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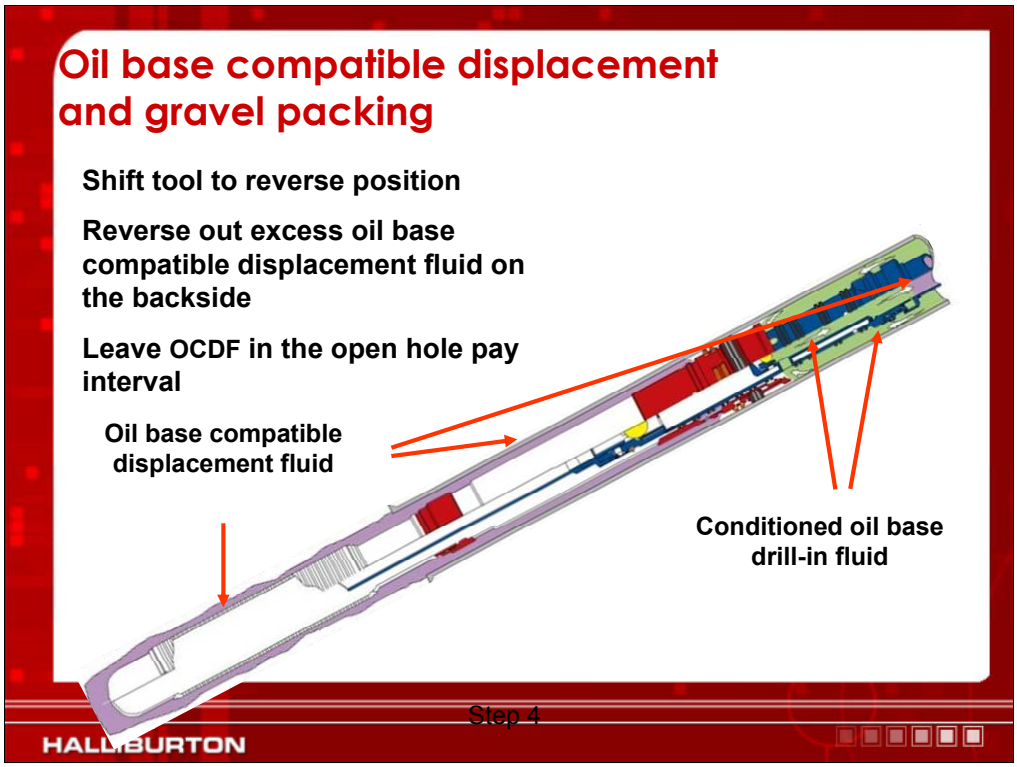
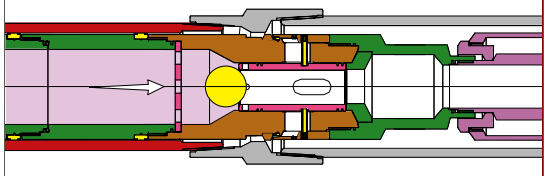


A minimum of two open hole volumes of OCDF displacement fluid is used to displace the conditioned oil base drill-in fluid out of the open hole pay interval in the previous step. The excess displacement fluid can now be reversed out up the workstring.

Actuated Reverse Ball Seat
Closed for Reversing Out



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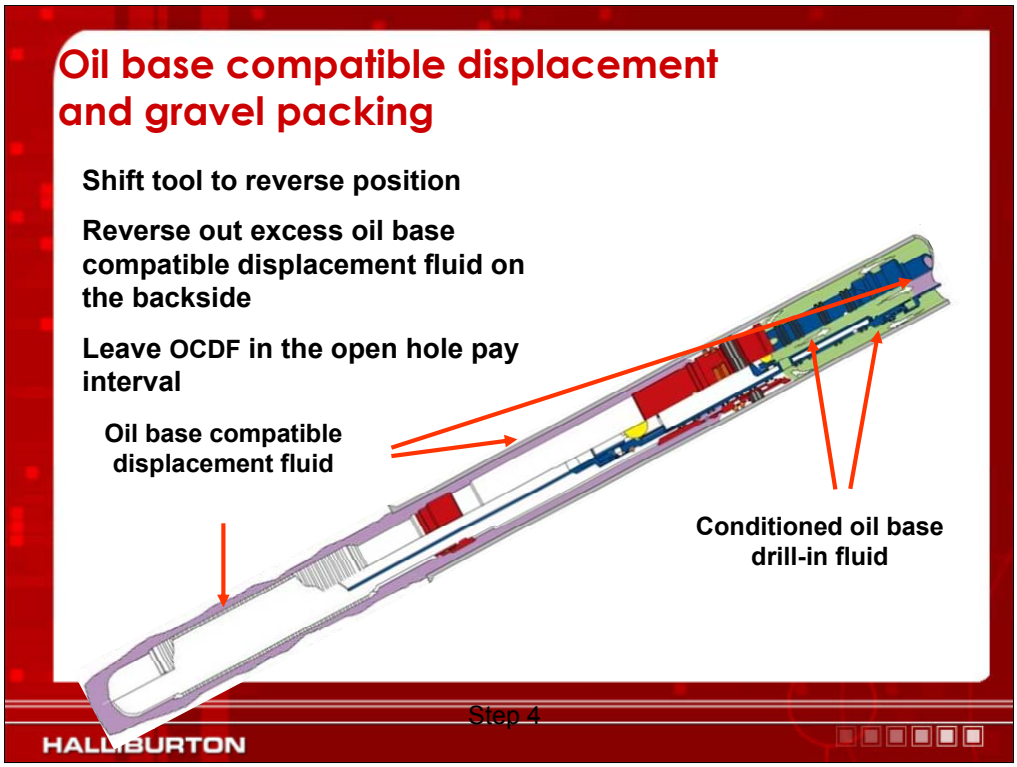

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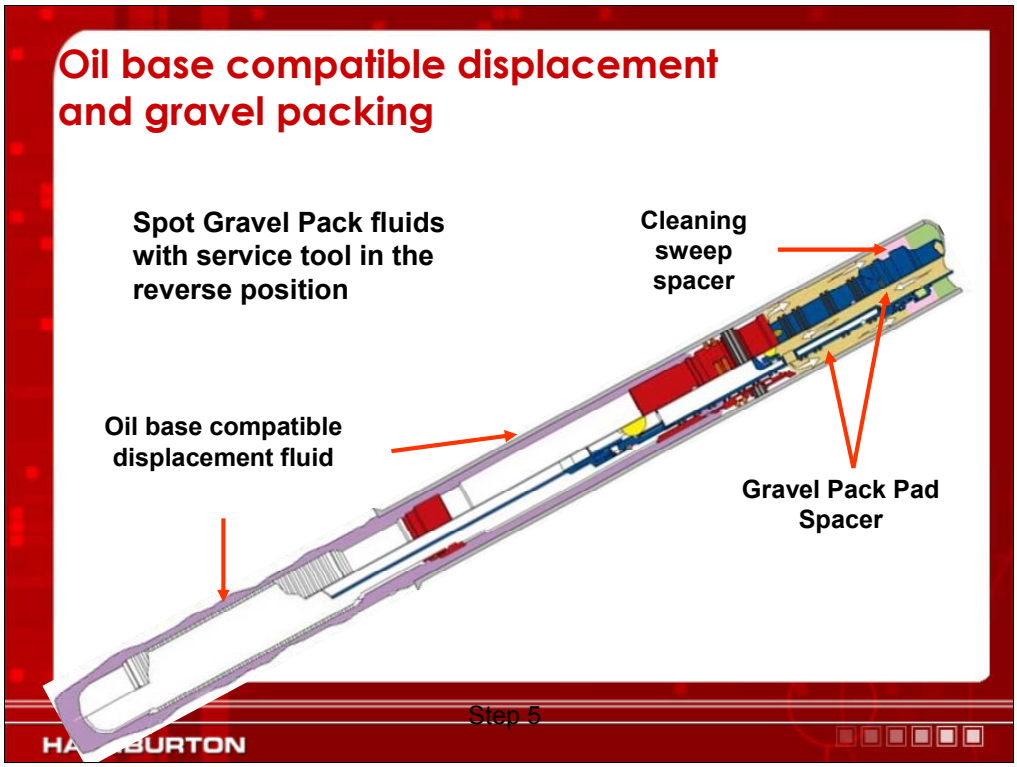
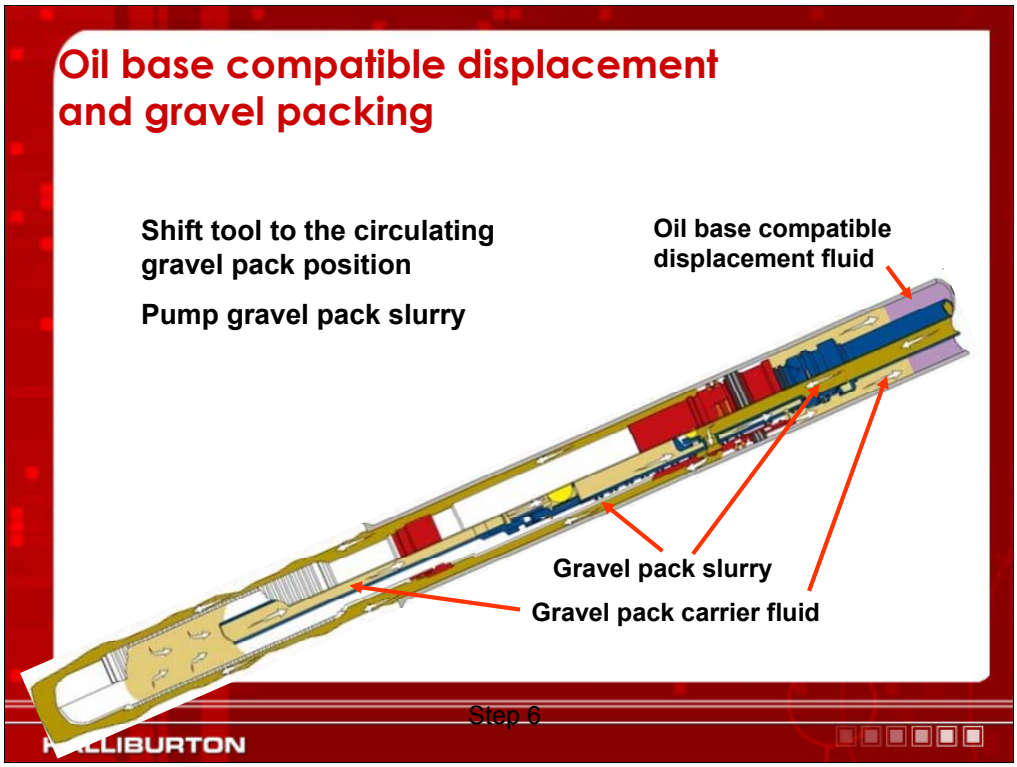
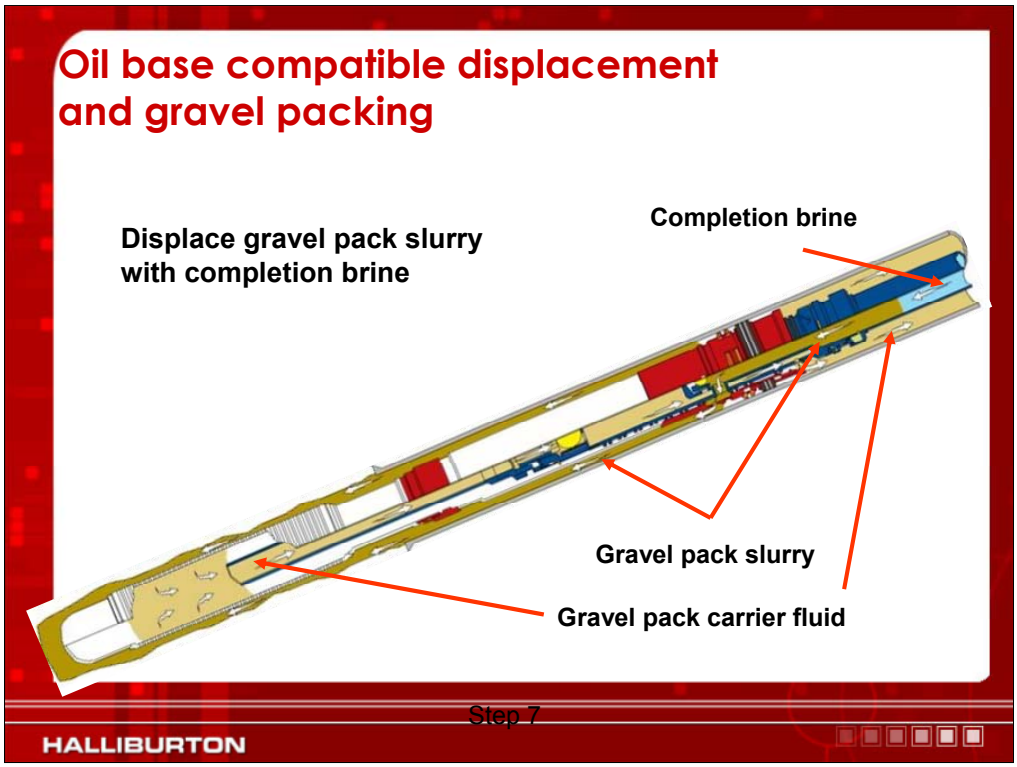


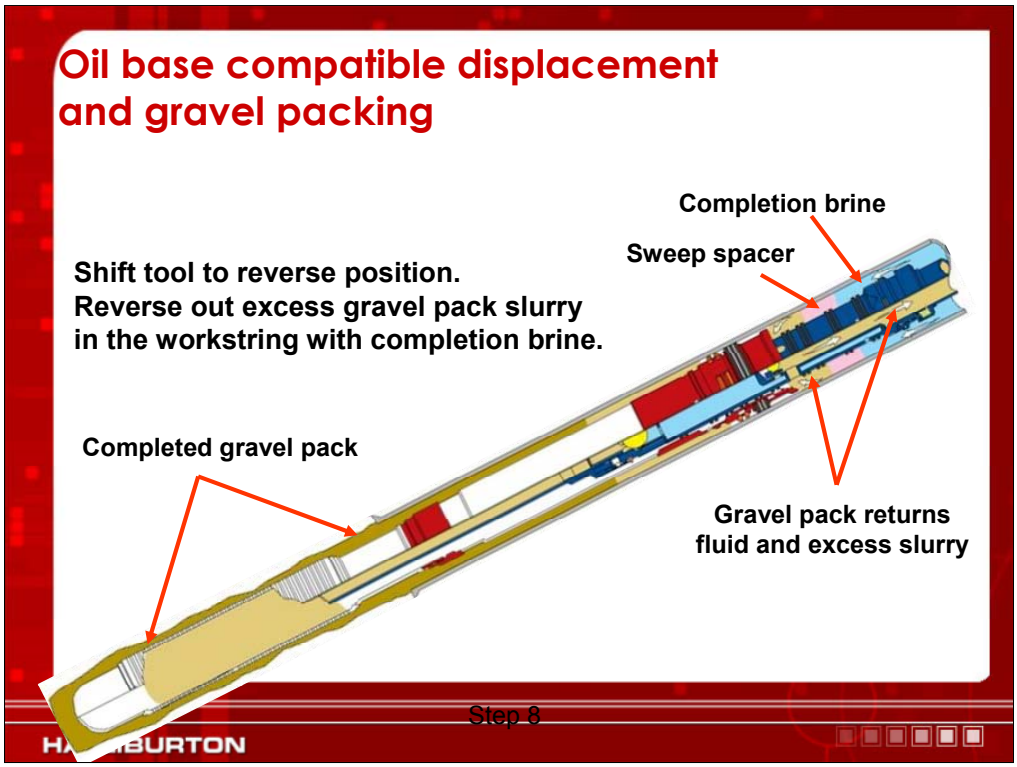
After reversing out the excess displacement fluid. the gravel pack fluid stages are spotted to the service tool in the reverse position. The gravel pack fluid stages include a surfactant sweep spacer, gravel pack fluid pad, the gravel pack slurry and completion brine to displace the fluid stages. The gravel pack pumping is performed with the tool in the weight down circulating position and fluid returns flow are taken up the workstring – casing annulus to surface to accomplish gravel placement across the interval covered with gravel pack screens.



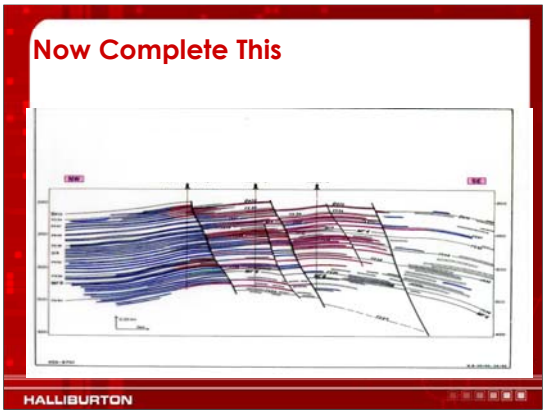
The tool is shifted to the weight-down circulating gravel pack position and the well is ready to gravel pack. The gravel pack pumping is performed with the tool in the weight down circulating position and fluid returns flow are taken up the workstring – casing annulus to surface to accomplish gravel placement across the interval covered with gravel pack screens.



The gravel pack slurry is displaced with completion brine. Gravel is filtered out of the slurry and retained in the screen-open hole annulus to form the gravel pack filter around the screen. Gravel pack carrier fluid circulation is taken up the washpipe, through the service tool and up the workstring-casing annulus to surface to complete the gravel pack process.

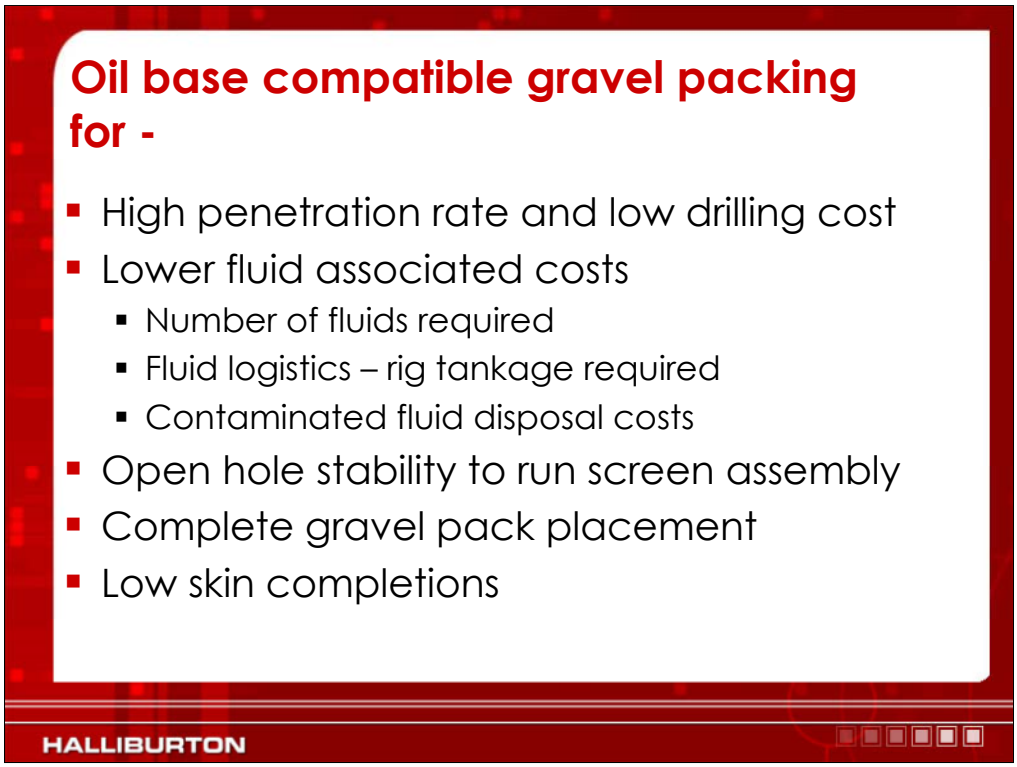


The service tool is shifted to the upper reverse position which actuates the reverse ball check. This effectively isolates the open hole from fluid flow into the reservoir in case fluid loss increased during the gravel packing process. With the reservoir isolated from fluid loss, the gravel slurry can be reversed out. Completion brine is pumped down the workstring-casing annulus to reverse out excess gravel slurry and gravel carrier fluid returns from the workstring-casing annulus. Completion brine is reverse circulated to fill the casing in preparation for performing the rest of the completion operations.



Stacked reservoirs like these are found in many areas. Open hole completions can sometimes be used to access these reserves more economically than possible with cased hole completions.

Ability to produce multiple pay intervals with a completion process that requires fewer steps and less rig associated costs. Completion options include bare screen, expandable completions and gravel packs. The pay zones can be co-mingled or open hole isolation packers, annular barrier tools and inner strings can allow zonal isolation for controlling the zonal flow and for improved reserve recovery.



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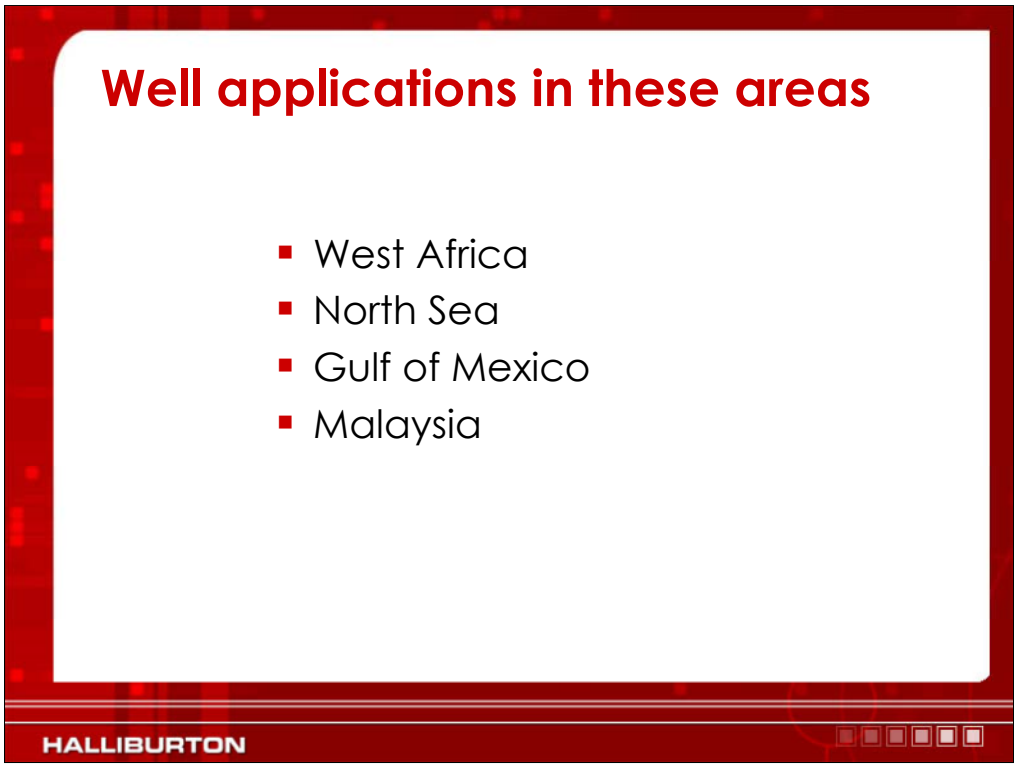

West Africa – Nigeria and Angola

North Sea UK sector

Gulf of Mexico – economy of ROP and fluids associated costs

Malaysia

To name a few.