



World Oil[®] **HPHT**

DRILLING, COMPLETIONS & PRODUCTION CONFERENCE

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HPHTConference.com

Wellbore Shielding Spacer Improves Cement Bond While Preventing Cement Losses

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Cementing & Stimulation

Impact Fluid Solutions

AGENDA

- **Spacer/displacement requirements**
- **Key spacer facts**
- **Wellbore Shielding technology**
- **Unique functionality**
- **Case histories**
- **Summary**

PRIMARY CEMENTING

“You only have one chance to cement a well correctly”

Objectives:

- **Bond pipe to formation**
- **Zonal isolation**
 - **Casing Job**
 - **Liner Job**

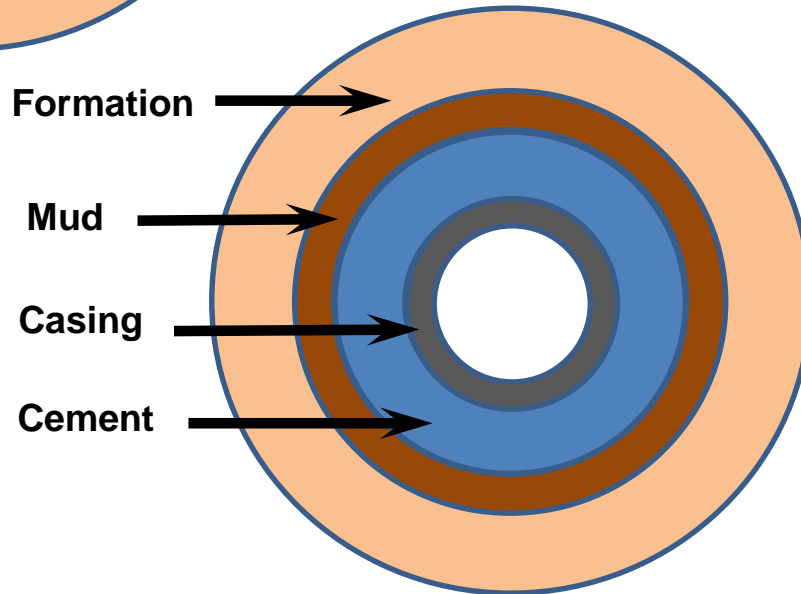
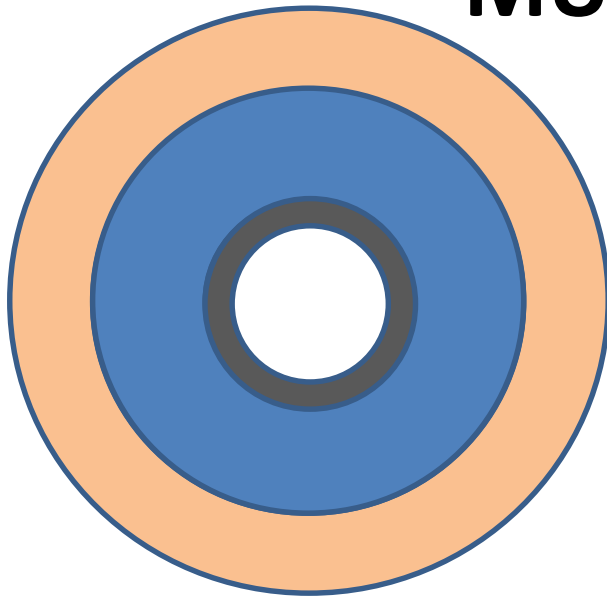


KEY DISPLACEMENT FACTORS

- **Mud**
- **Spacer**
- **Centralization**
- **Rate**
- **Slurry factors**
- **Pipe movement**

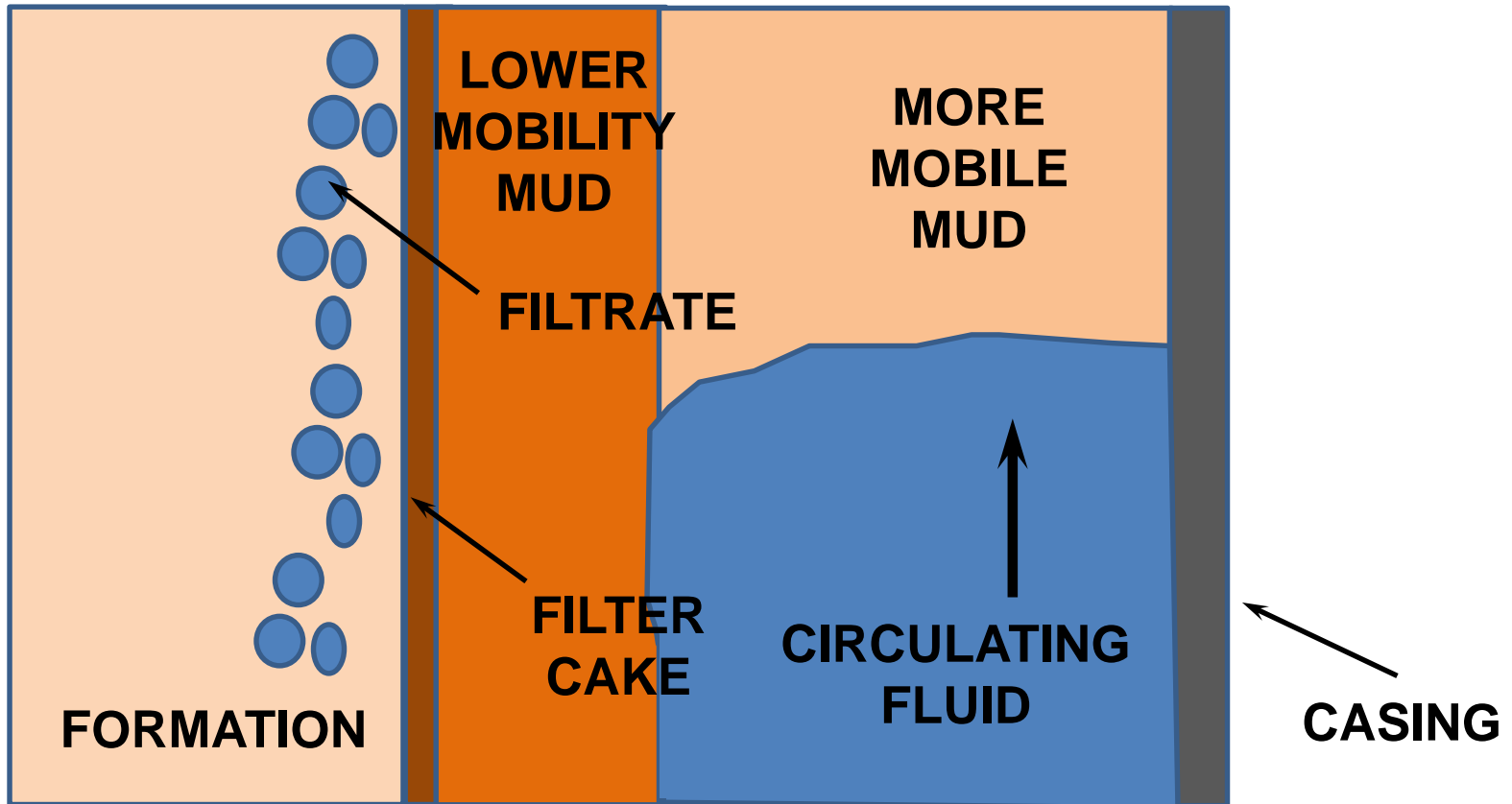


MUD DISPLACEMENT

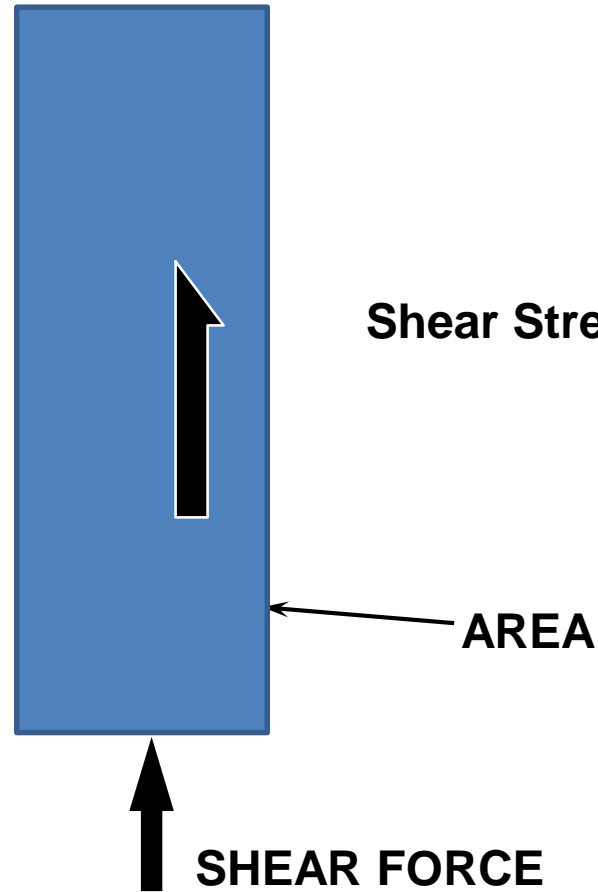
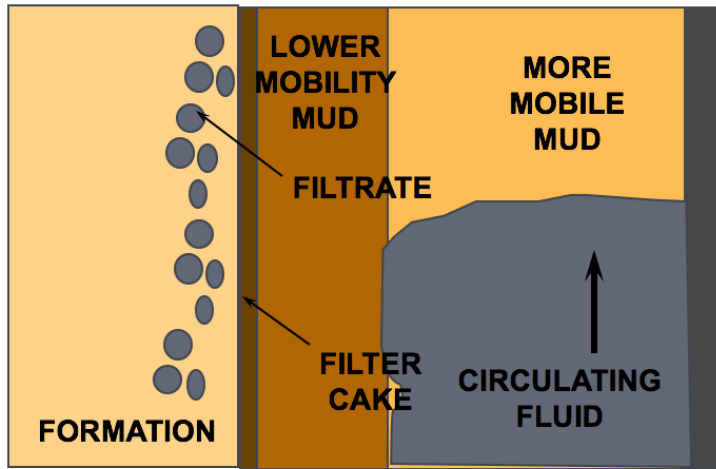


- **Allow inter-zonal communication**
 - Lost production
 - Unwanted production
 - Corroded casing
- **Squeeze jobs**
 - \$4,000 to \$1,000,000

MUD DISPLACEMENT

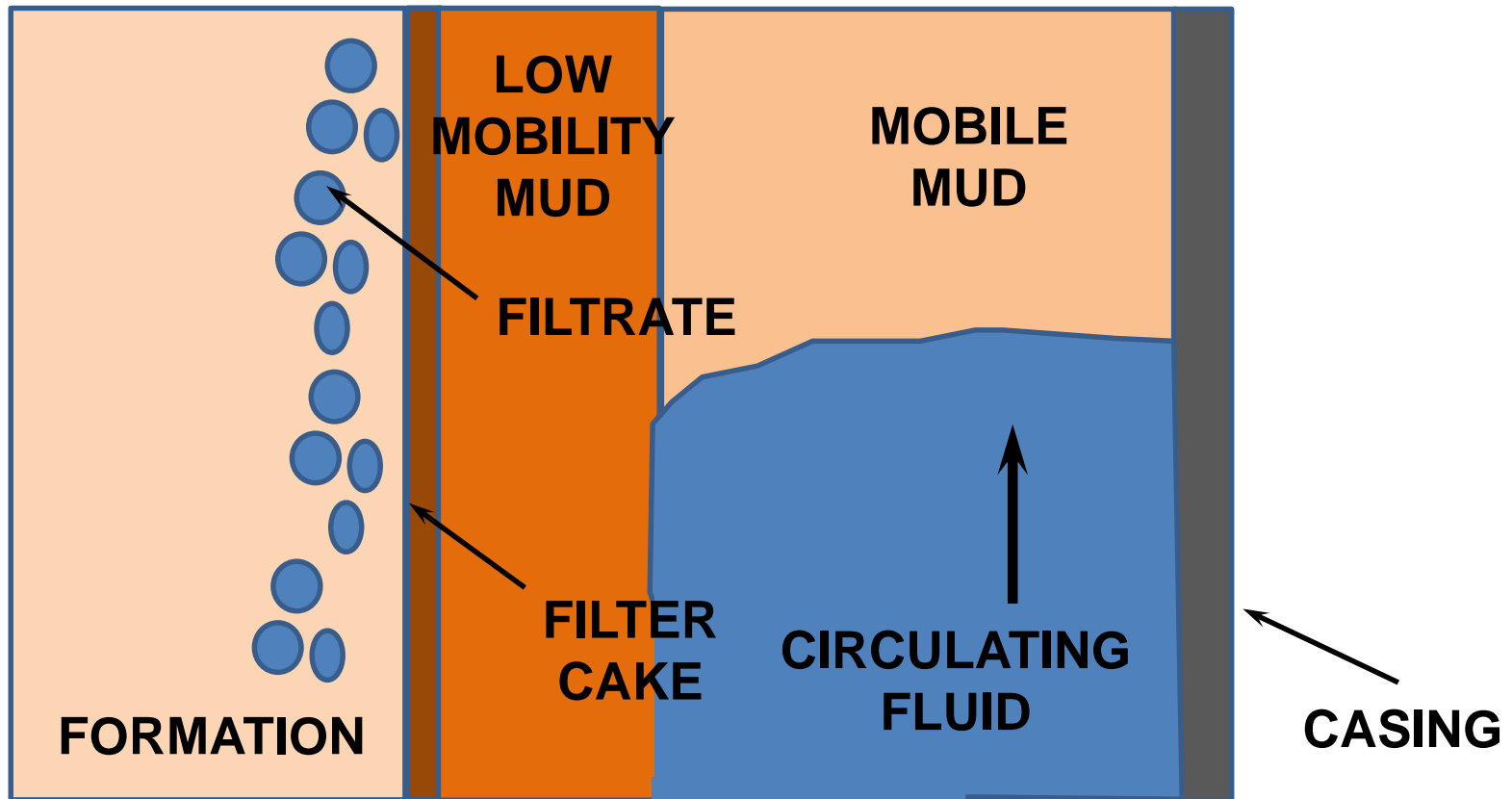


SHEAR STRESS



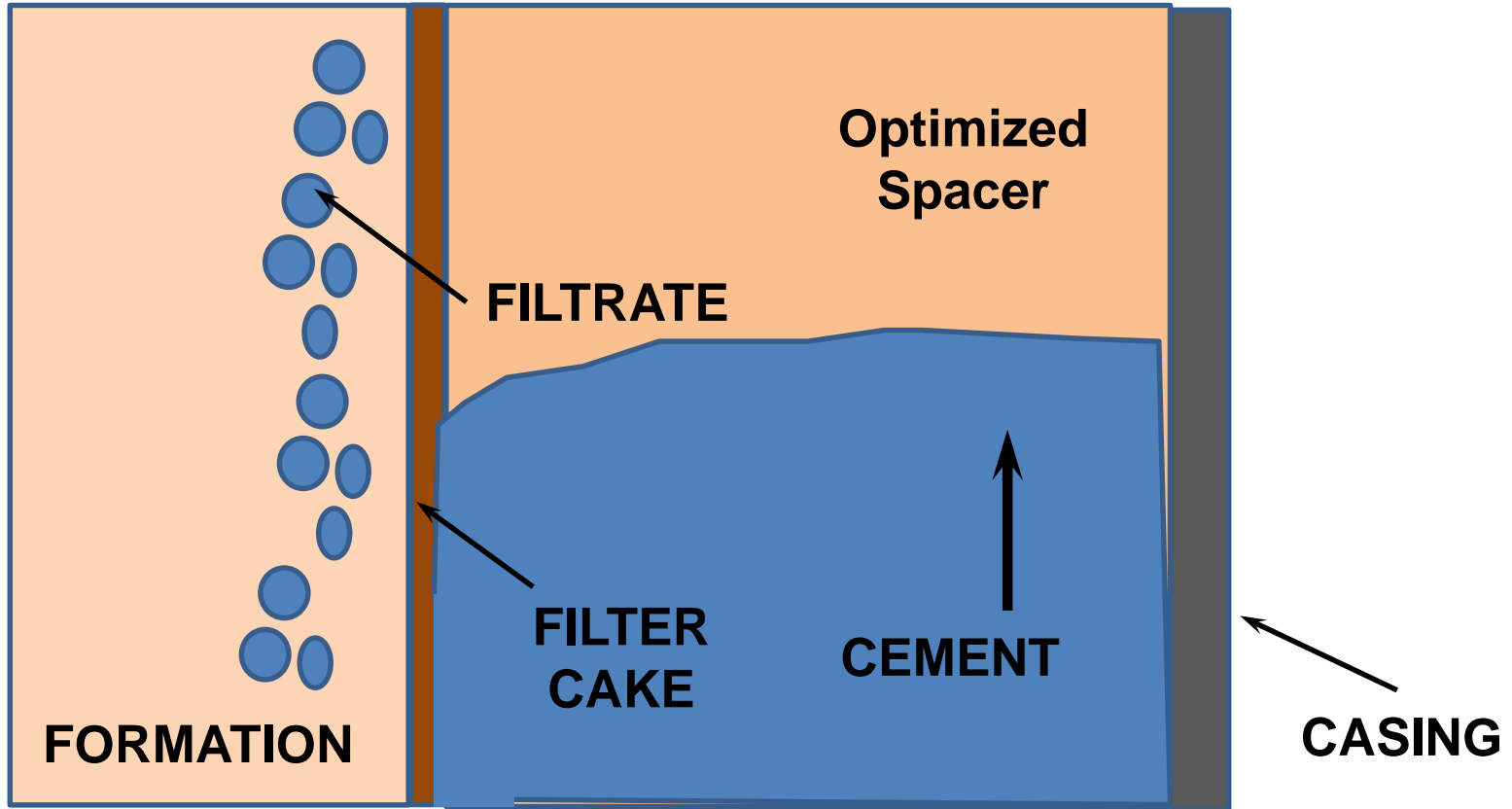
$$\text{Shear Stress} = \frac{\text{Shear Force}}{\text{Area}}$$

POORLY DISPLACED MUD



Drilling vs Cementing

FULLY ERODED MUD



SPACERS and FLUSHES

- **Fluid compatibility**
- **Fluid separation**
- **Aid in mud displacement**
- **Formation protection**
- **Solids suspension**

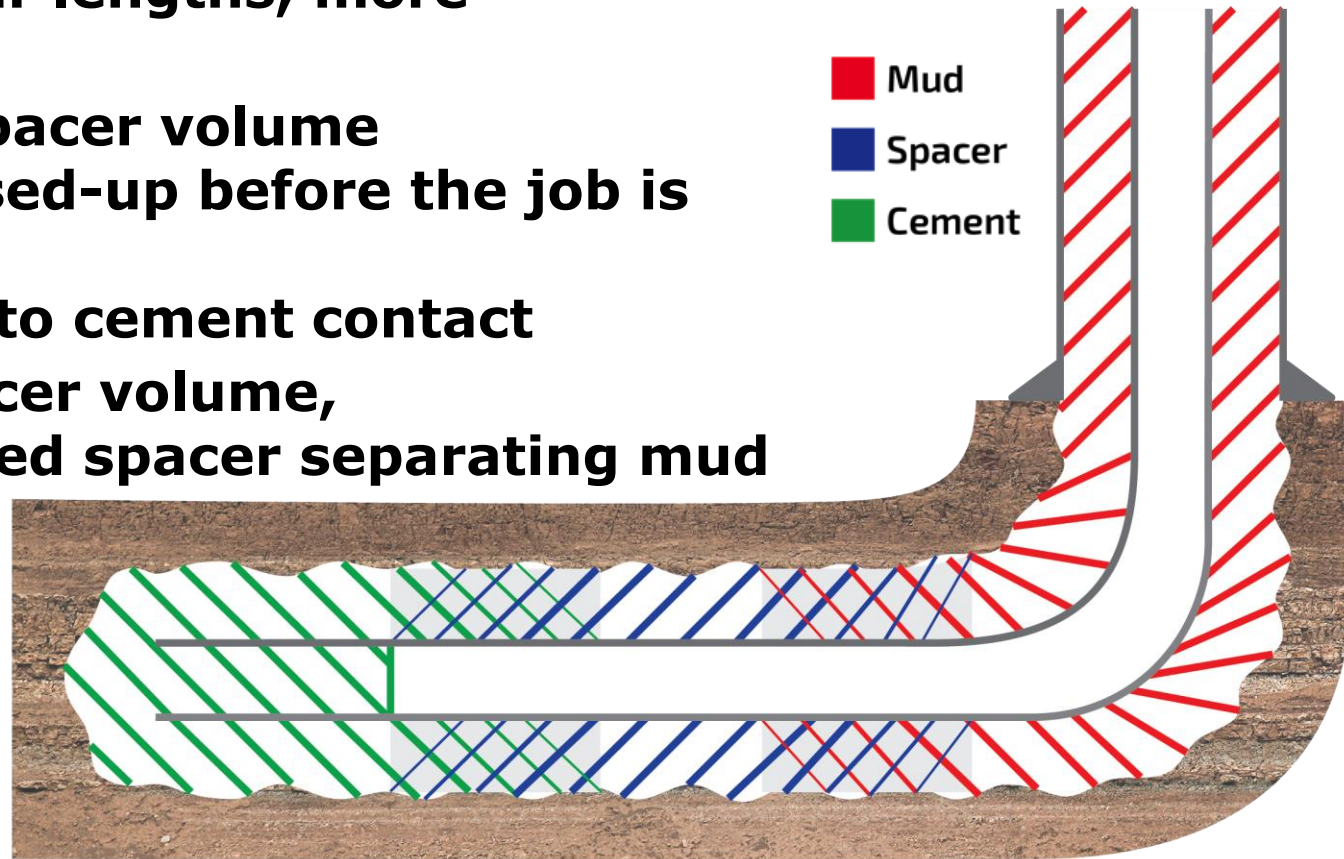


SPACER DESIGN

- **Maximum displacement**
- **Better hole clean out**
- **Improved hydraulic bonding in oil-based muds**

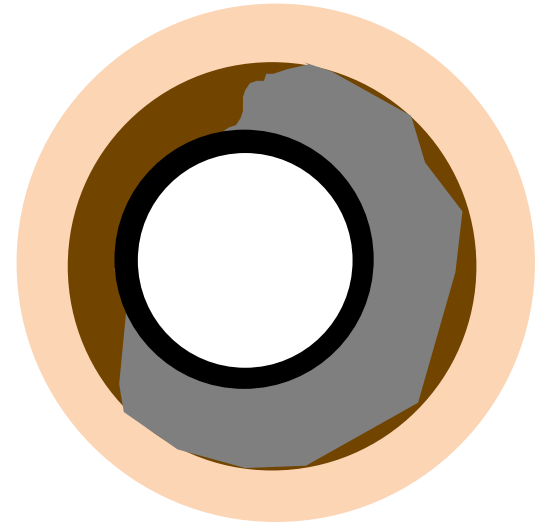
INTERMIXING FACTS

- **Spacer and drilling fluid intermix**
- **Spacer and cement intermix**
- **Longer annular lengths, more intermixing**
- **Insufficient spacer volume**
 - **Spacer is used-up before the job is complete**
 - **Direct mud to cement contact**
- **Sufficient spacer volume, uncontaminated spacer separating mud and cement**



DISPLACEMENT RELATED VISCOSITY FACTS

- **Fluids follow the path of least resistance**
- **Eccentric pipe, a path of least resistance is created**
- **Wide sides have less friction**
- **Fluids differentially flow, wide side**
- **Thin spacers follow the path**
- **Thicker spacers flow in the wide side, but more will flow through the narrow side**



ECCENTRICITY FACTS

- **Flow is differentially up the wide side**
- **More eccentricity, the greater the difference**
- **Too narrow, narrow-side rate approaches zero**
- **Pump rate and viscosity affect how close to zero**
- **Early cement returns often indicate poor displacement efficiency**
- **With eccentricity, there will be 2 TOCs**
 - **Wide-side TOC will be high, but without zonal isolation**
 - **Only lower narrow-side TOC provides zonal isolation**

SPACER SYSTEM

Wellbore Shielding Spacer (WBS)

- **Hole cleaning**
- **Separation**
- **Loss prevention and cure**

WELLBORE SHIELDING SPACER

1. WBS cementing spacer

- One sack blend
- HTHP proven
- Mix on the fly capability
- Minimizes or eliminates losses
- > 10,000 jobs

2. WBS lost circulation material

- LCM with optimized PSD for use in WBS spacer
- Safe for use through floating equipment and liner hangers
- ~4MM lb pumped
- Effective for porosity up to 3500 Darcy and natural fractures of 1 or 3 mm

WELLBORE SHIELDING SPACER

Basics

1. Separation of mud and cement

- Effective
- Compatible with HTHP muds & cements

2. Mud displacement

- Effective
- Tunable rheology
- Thicker or thinner with more or less of the spacer additive

3. WBS spacers can prevent ECD resulting induced losses from

- Heavy cement
- Optimized displacing rates

4. WBS spacers can stop existing losses

WELLBORE SHIELDING SPACER

- **Proprietary Wellbore Shielding®** technology reacts upon contact with the formation to stop fluid flow
- **Prevents and/or reduces lost circulation problems in fragile, unconsolidated and fractured formations**
- **Seals the formation allowing better cement placement, improving the cement bond**



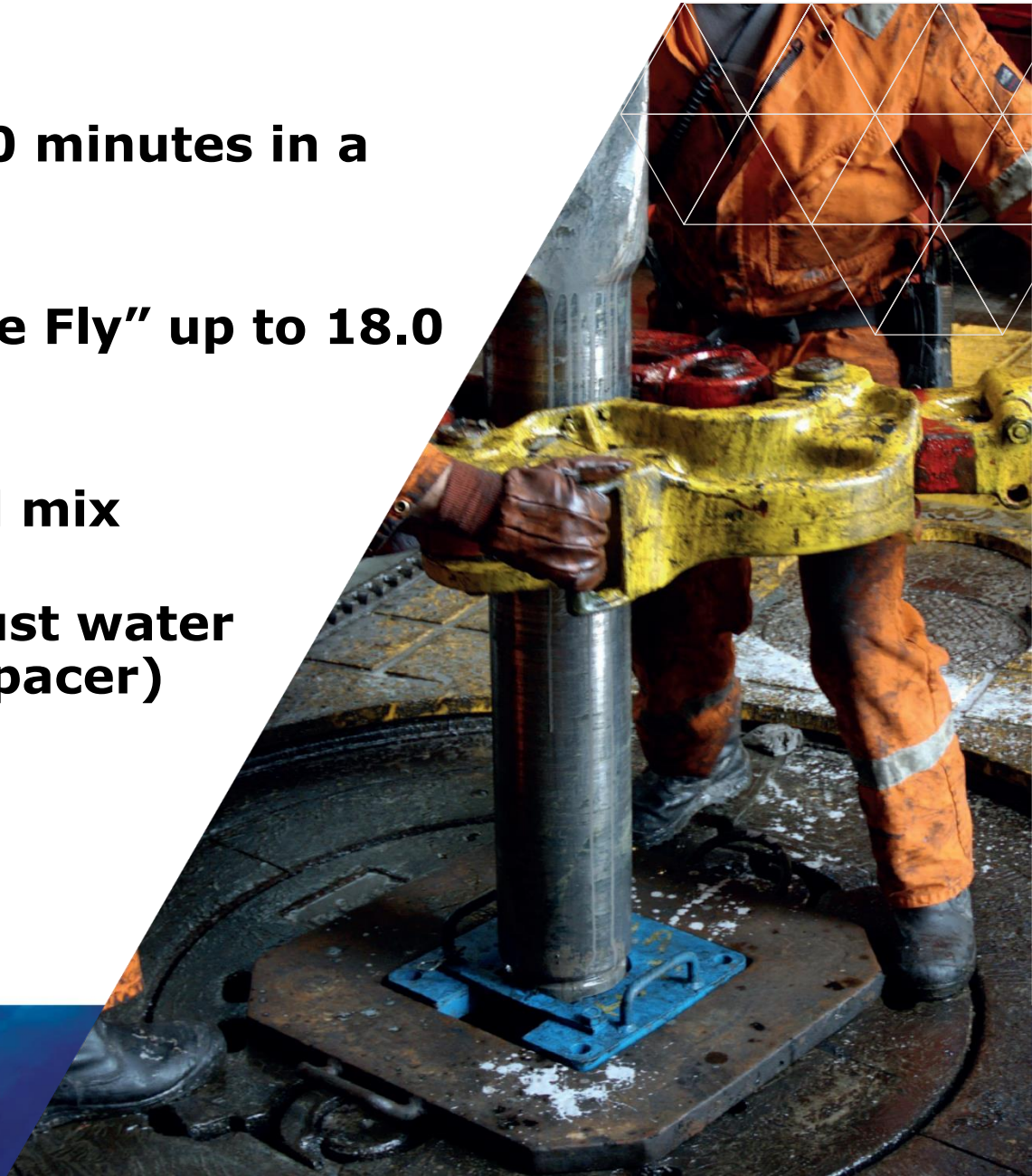
BENEFITS

- **Improves zonal isolation**
- **Allows higher ECD's without formation breakdown**
- **Reduces cement fall-back**
- **Enables superior hole-cleaning performance**
- **Environmentally friendly**



FEATURES

- **Easy to mix (15 to 30 minutes in a batch mixer)**
- **Can be mixed “On the Fly” up to 18.0 ppg**
- **Spacer is a dry blend mix**
- **Can be mixed with just water (as an unweighted spacer)**

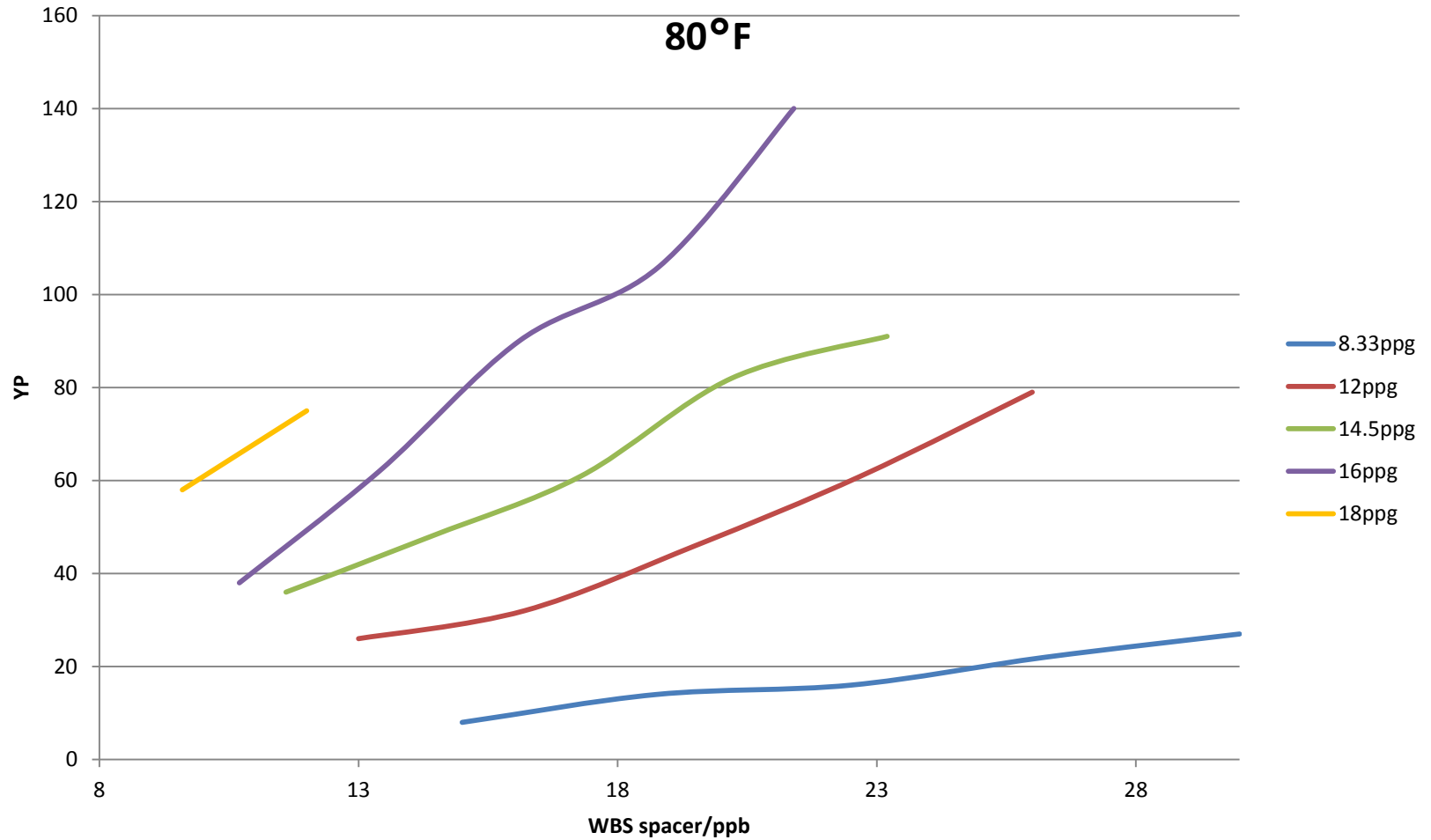


APPLICATIONS

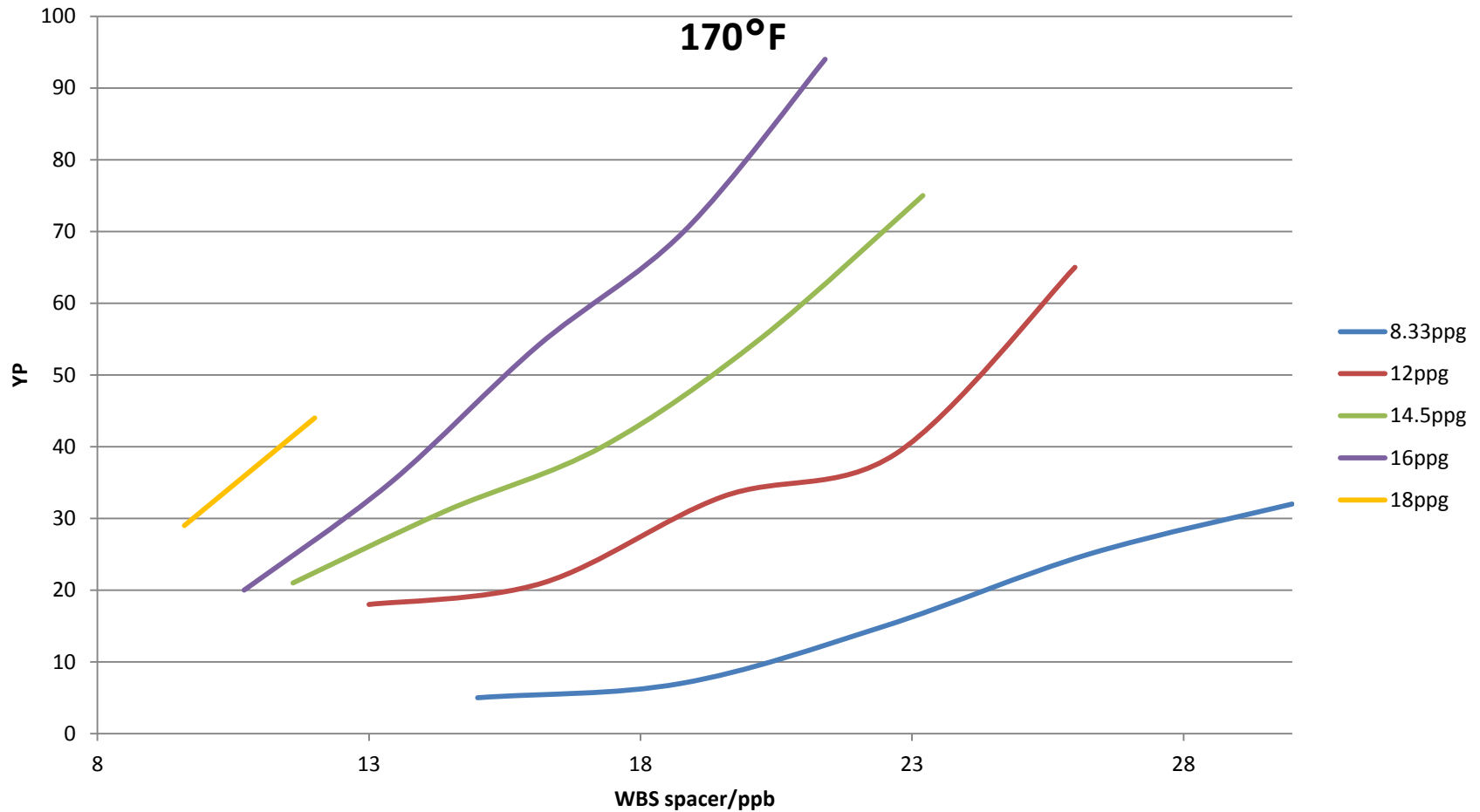
- **Lost circulation - partial to total loss of mud returns**
- **Across depleted intervals**
- **With low or tight ECD margins – where fracture gradients and mud weight limits cement density**
- **In naturally fractured formations**
- **Cement fall-back**



YP LINEARITY at 80°F

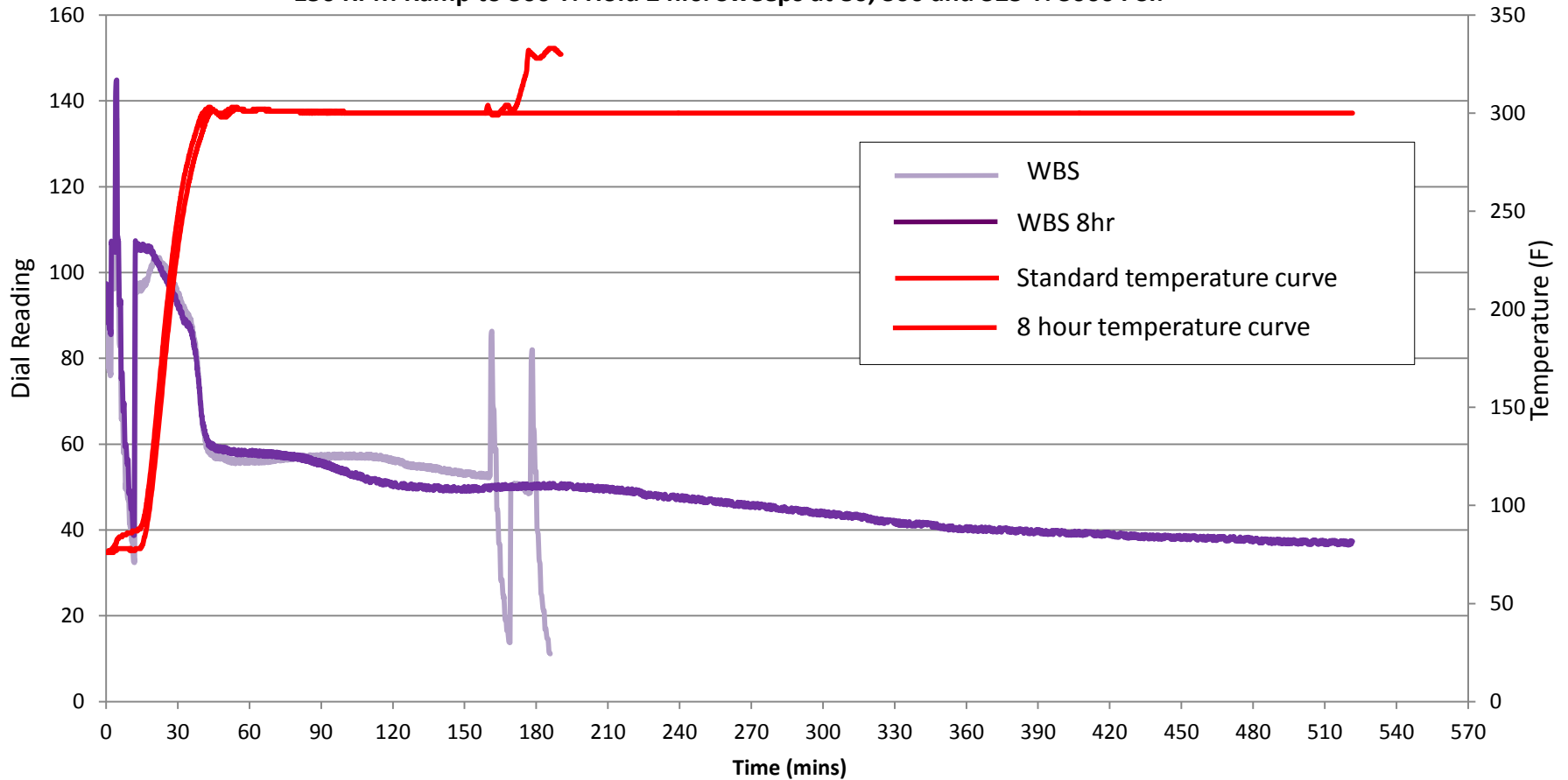


YP LINEARITY at 170°F



GOOD STABILITY UP TO 350 DEG F

8 hr unweighted HPHT rheology profiles - extended test
150 RPM Ramp to 300°F. Hold 2 hrs. Sweeps at 80, 300 and 325°F. 3000 PSI.



SAND BED TEST FOR FLUID LOSS

Dry 20/40 frac sand at 100psi

Fluid (UW)	WBS (15ppb)	WBS (30ppb)
Initial invasion/cm	5.4	2.0
Final invasion/cm	6.7	2.6

SAND BED TEST FOR FLUID LOSS

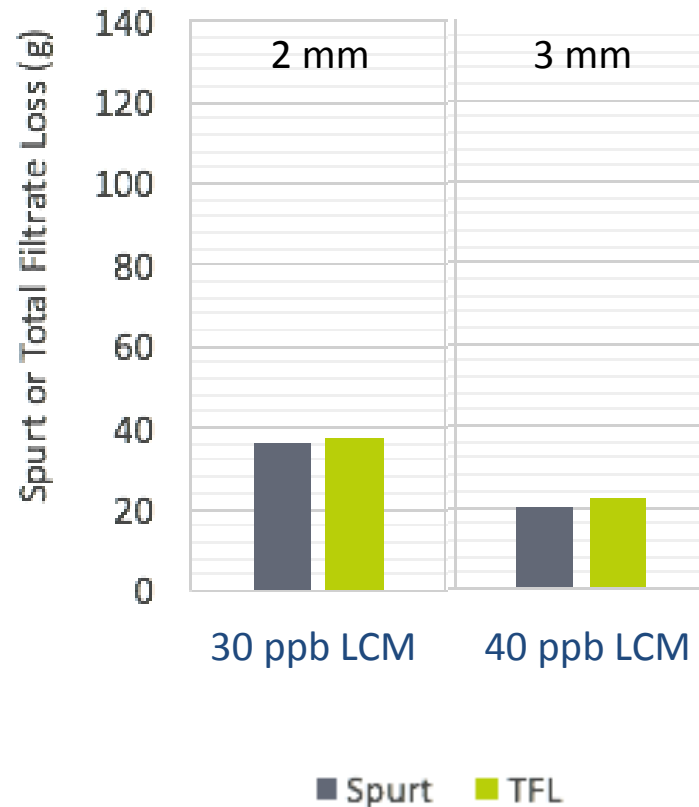
Pre-wetted 20/40 frac sand

500 PSI		
Time (min)	WBS 15ppb (ml)	WBS 30ppb (ml)
1	67.1	39
15	75.3	42.2
30	78.5	44

1000 PSI		
Time (min)	WBS 15ppb (ml)	WBS 30 ppb (ml)
1	94	45
15	100	48.7
30	103.5	50.7

SLOT DATA

30ppb slurries of WBS with 30 and 40 ppb of LCM tested across 2mm and 3mm; 1000psi (gas), Room Temperature



SHIELD AGAINST INVASION & INSTABILITY

WBS additives are built on proprietary chemistry that forms flexible “shields” in the fluid system, producing an extremely low-permeability barrier on the face of the wellbore.

Unlike conventional wellbore strengthening techniques, the shielding barrier is stable under high shear and high temperature conditions.

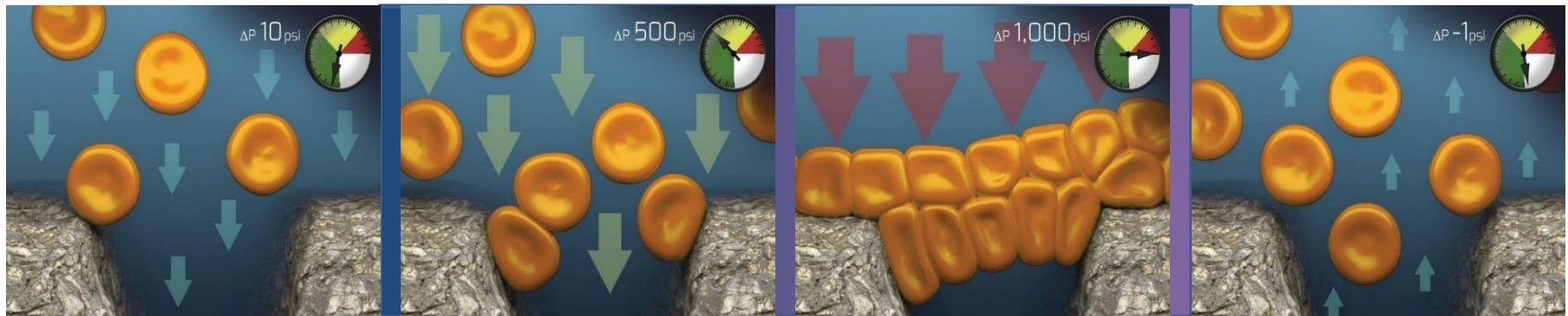


Figure 1
Initially, the Wellbore Shielding® particles are free-floating in the fluid.

Figure 2
As differential pressure increases, the shielding particles migrate toward the formation and begin to form a protective barrier.

Figure 3
At max differential pressure, the shielding particles form a nearly impenetrable surface layer.

Figure 4
As the differential pressure is released, the shielding particles return to the flowing fluid, leaving the formation permeability with essentially no damage.

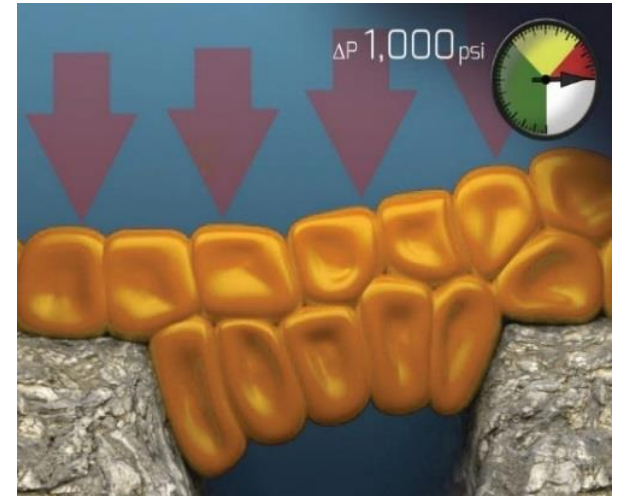


CASE HISTORIES

UNCONSOLIDATED FORMATION

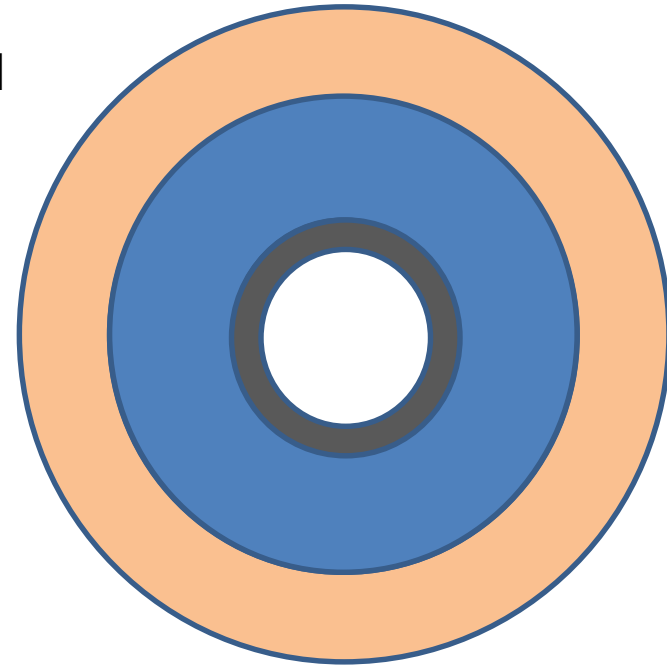
20" & 13 3/8" casings were problematic

- **20" averages**
 - **11.5 top jobs**
 - **1047 bbl remedial cement**
 - **With WBS spacer 2 top jobs & 138 bbl spacer**
- **13 3/8" averaged**
 - **8 top jobs**
 - **With WBS spacer 2 top jobs**
- **\$199,640 vs \$529,144**



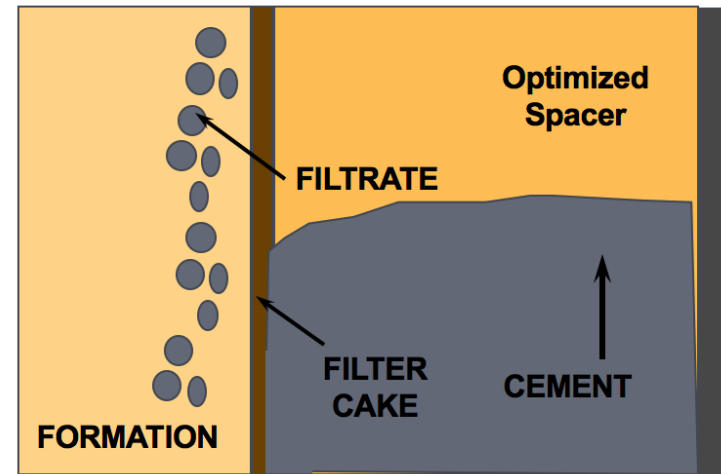
CIRCULATE CEMENT W/O STAGE TOOL

- **Losses to formation required stage tool**
- **9 5/8" casing**
- **Prior to cementing**
 - **Static losses averaged 81 bbl/hr**
 - **Dynamic losses averaged 120 bbl/hr**
- **During drilling w/standard LCM**
 - **Static losses averaged 65 bbl/hr**
 - **Dynamic losses averaged 100 bbl/hr**
- **With WBS spacer**
 - **Cement returns observed on surface**
 - **Single stage cement job**



Summary

- **Cementing**
- **Displacement efficiency**
- **Spacer**
- **Wellbore Shielding technology**
 - **Prevent induced losses**
 - **With LCM cure existing**
- **> 10,000 applications**



QUESTIONS