



SURE-SEAL™ LPM TECHNICAL BULLETIN

INTRODUCTION

Lost circulation is the most costly mud related drilling problem, and induced fracture lost circulation is probably the most common type, faced by the oil and gas industry. Wellbores break down and induced fracture lost circulation occurs when the hydraulic pressure in the wellbore exceeds the breakdown pressure of the weakest formation exposed.

PRODUCT DESCRIPTION

SURE-SEAL™ LPM is a proprietary natural Loss Prevention Material (LPM) for use in wellbore strengthening procedures. SURE-SEAL™ LPM significantly increases near well bore formation fracture resistance by inhibiting the initiation and propagation of fractures before loss circulation begins. LPM's have shown in field applications to increase fracture resistance by 3-6 ppg and more. SURE-SEAL™ LPM is a cost effective LPM and can be used in either water-based or oil-based drilling fluids. SURE-SEAL™ LPM is a highly durable additive that has minimal impact on fluid density or rheology even at concentrations of 50 ppb.

ADVANTAGES

- Product is all natural and therefore biodegradable
- Product is a high strength material with a compressive strength of >8000 psi
- Product is a resilient material with an Elastic Modulus of 965 kpsi and a Percent Resiliency of 20.0%
- Hardness is 3 on MOHS scale
- Specific Gravity is between 1.2 – 1.4
- Works in drilling fluids of any pH
- Acid solubility in 15% HCl at 150 °F is 41.76% after a 16 hr. soak
- Product is a low crush material and is less brittle than many other LCM's such as calcium carbonate
- Product absorbs less water than many other natural LCM's
- Product is granular and packs tighter than fibrous shaped LCM such as cedar fiber or mica
- Product is slightly deformable but not too deformable such that it forms a better seal and has a lower fracture conductivity value than other deformable materials
- Product maybe used in high concentrations with minimal impact on fluid density

- Product has minimal effects on rheology compared to other LCM's such as cedar fiber and cotton seed hulls
- Maybe used in either water-based or oil-based fluids
- Cost effective compared to other LPM's currently on the market such as deformable graphite

APPLICATIONS

STRENGTHENING: USING SURE-SEAL™ LPM A SIMPLE APPROACH

A method of treating for potential loss of circulation is to slug the hole with very high concentrations (50 - 100 lb/bbl) of SURE-SEAL™ LPM but do it by spotting the high concentration slug across the zone of concern during trips. On trips the swab and surge pressure would effectively create fractures for a very short time and then allow them to close. This seems like an obvious best practice and would have the potential to give the desired result with no increase in cost or time. Spotting a pill of SURE-SEAL™ LPM ahead prior to running casing and cement is good practice if there is a zone exposed that is unlikely to support the cement. Running casing can give a high surge pressure effectively producing the equivalent of a series of short hesitation squeezes. This gives the formation a very high concentration exposure with the potential to seal any frac exposed.

WELLBORE STRENGTHENING PROCEDURE

There are two ways to apply a wellbore strengthening treatment to a weak zone.

1. The drilling ahead method.
2. The Pill method, formation integrity test (FIT) method or leak off test (LOT) method.

DRILLING AHEAD METHOD

Treat the entire drilling fluid system with SURE-SEAL™ LPM and drill the weak zone with the LCM in the drilling fluid. Since the LCM has a large particle size, the shakers have to be fitted with 20 or 40 mesh screens or coarser to keep the effective material in the system (or bypass the shakers altogether). It is desirable and necessary to keep the full particle size spectrum in the system. As the weak zone is drilled, small short fractures will be created, but filled and plugged with the LCM. The weak zone will be sealed and strengthened. As the mud weight (density) is raised, more small fractures are formed and plugged. This method is the most effective but is best to limit drilling to about 500 feet because of the buildup of drill solids in the mud system. See formula below for treating the entire system. If you need to drill further than 500 feet it is best to replace the entire system with a fresh system.

THE PILL METHOD

Before drilling out of the shoe, determine the depth of the expected “weak” section. Conduct a formation integrity test (FIT) or leak off test (LOT). If the shoe test fails, drill this section with treated mud as far as it is necessary to get to a formation that will have the desired rock strength. The depth will have to be predicted based on offsets and other data. All formations below this point should be strong enough to withstand the highest ECD predicted for the rest of the well. In other words, choose a point where a drilling liner would be set.

Change shaker screens to 20 mesh or coarser, or bypass shakers. Before drilling ahead, add SURE-SEAL™ LPM and CaCO₃ *adding CaCO₃ to the mud for shales is not a functional treatment!* In sands, with much larger pore throats, CaCO₃ is desirable. Adding the materials through the mud hopper will ensure good mixing and distribution throughout the mud system and prevent any plugging of MWD tools or mud motors. The special LCM blend will have to be maintained in the mud at all times. The ECD (equivalent circulating density) at the end of this section will have to be the maximum ECD expected at TD (total depth). This ensures that when TD is reached, the upper section will have already been exposed to this ECD with the strengthening LCM blend in the drilling fluid. The LCM blend may be removed from the drilling fluid, and drilling to TD can continue as per plan, as the weak section has been strengthened.

BORE HOLE STRENGTHENING: SQUEEZE PROCEDURE

SURE-SEAL™ LPM is used as a component of a special fluid to drill formations that would be likely to frac with existing drilling fluid density, and which need to be strengthened. For this application, a very clean fluid is used to keep the solids distribution constant. If the formation of concern is sand, then a blend of calcium carbonate and SURE-SEAL™ LPM may work as well as straight SURE-SEAL™ LPM. *For shale formations straight SURE-SEAL™ LPM is clearly superior and the calcium carbonate adds little if anything to hole-strengthening!* This special fluid may be mixed and stored until the zone of concern is to be drilled and then used just to drill that zone. These fluids in addition to the SURE-SEAL™ LPM also have a very low fluid loss. In this case, it is desirable to run more coarse screens to avoid shaking out the coarse fraction of the material. A particle size distribution, up to the size of the fracture, is optimal.

THE FOLLOWING ARE RECOMMENDED STEPS FOR A SQUEEZE PROCEDURE

SPOTTING/FIT METHOD OR PILL METHOD

Drill through the entire weak zone with a low mud weight, treat the zone with the special LCM in a series of FIT squeezes, and then drill ahead raising the mud weight as needed for pore pressure or hole stability. This method is operationally easier, but there is a risk that if the wellbore breaks down during the FIT test, the fracture may extend so far from the wellbore that it cannot be repaired.

Drill to the predetermined top of the stronger rock (bottom of the weak rock). Circulate the hole clean at this point. While drilling, build LCM pill volume big enough to cover entire open hole plus 100 feet up into the casing plus 10 bbls. Add SURE-SEAL™ LPM and CaCO₃ through the mud hopper to ensure good mixing of the products. Use the formula below to treat the entire system, except increase SURE-SEAL™ LPM concentration to 30 – 50 ppb. As long as it is well mixed, this formulation should go through the MWD, mud motor and other down-hole tools without plugging. Check tool tolerances with manufactures or down hole drilling service companies to reduce or prevent plugging. This pill should have good suspending properties to prevent dropout of the large CaCO₃ in the drill string.

Spot the pill in the open hole and up into the casing, leaving about 10 bbls in the drill pipe. Perform a series of FIT's to drive "wedges" of the LCM material into the wellbore wall at the weak zones. Pump down the drill pipe at a controlled rate of about ¼ bbl/min. Carefully plot pressure vs. time and carefully record volumes pumped and returned. When the pressure/volume line is definitely bending over, stop pumping. If the well breaks down, stop pumping immediately to limit the growth of the fracture. If the fracture gets too far from the wellbore, the method may fail. Bleed the pressure off over about a minute, if possible. If the zone is permeable wait 5 minutes to do the next FIT to allow any leak off to occur in the fracture. Repeat until the desired wellbore pressure is achieved. Some mud should have been lost to the formation (not returned when pressure released). This indicates that mud with the LCM blend was forced into short fractures and leaked off. For a long zone, this might be 2-10 bbls.

This section should now be "strengthened". Circulate the pill out of the hole and either separate it for use as a later LCM pill, or let it mix into the drilling fluid. Put the 200 mesh screens back on the shakers and drill ahead as per program.

THE FORMULATION OF THE SPECIAL LCM IS AS FOLLOWS

Formula for treating the entire mud system:

1. 15 ppb of SURE-SEAL™ LPM (250 – 600 micron) range. For a 1500 bbl circulating system, this would require 450 50lb sacks
2. 10 ppb of CaCO₃ in the (200 – 600 micron) range = 300 50 lb sacks
3. 10 ppb of CaCO₃ in the (50 – 150 micron) range = 300 50 lb sacks
4. If unweighted, 10 ppb of CaCO₃ in the 5 – 10 micron range. If the mud has barite in it, then this CaCO₃ fraction is unnecessary.
5. For a formation with no permeability (shale, marl, and tight siltstone) the mud must be ultra-low fluid loss. This would be < 0.5 ml HTHP (high temperature high pressure) fluid loss at maximum BHT (bottom hole

temperature). This can be achieved in OBM with a combination of organophillic lignite, Gilsonite, **Soltex® Additive**, or a polymeric fluid loss material, and emulsifiers. The polymeric material may be a key to getting the low fluid loss. An O/W (oil/water) ratio of no higher than 70/30 is preferred.

Formula for treating a weak zone with a pill:

1. Use the same formula above, except increase the SURE-SEAL™ LPM concentration to 30 – 50 ppb.
2. For an open hole of 1000 feet with a diameter of 8.75" + 10% hole wash out a pill of 100 bbls is required and will take 60 to 100 sacks of SURE-SEAL™ LPM. **Remember you must cover all the open hole plus 100 feet of casing plus 10 bbl. for the drill pipe.** There must be a complete distribution of particle sizes from the largest on down so that a filter cake will form on the large plugging particles at the fracture tip. The SURE-SEAL™ LPM has been shown to be important for both its particle size distribution and its characteristic of resiliency. CaCO₃ alone is not as effective, especially in impermeable rock. **When treating impermeable rock use only SURE-SEAL™ LPM and treat at 50 to 100 pounds per barrel.** Using the same example above the number of sacks of SURE-SEAL™ LPM would then be 100 – 200 sacks.
3. Depending on the particle size distribution of available CaCO₃, adjust the formula above. The idea is to have some CaCO₃ at the same size range as the SURE-SEAL™LPM, and some CaCO₃ in the size range between 50 microns and 200 microns – to bridge the gap between barite and the SURE-SEAL™ LPM.
4. Note; that for long hole sections, an applied pressure at the surface exerts a higher EMW (equivalent mud weight) pressure at the shoe than at TD (total depth). Calculate the range of EMW that will be applied with various applied surface pressures.

Note: The method of using SURE-SEAL™LPM to strengthen a wellbore must be applied to a wellbore that has not yet broken down. Wellbore Strengthening is a preventive procedure and treatment. Once an induced fracture has been initiated and it extends far from the wellbore, this technique will probably not work! It cannot be used as a corrective method for lost circulation once a significant drilling fluid volume has been lost! SURE-SEAL™LPM is not recommended for use in formations with vugular structures; open fractures; or in shallow gas zones that are loosely consolidated with gravel and or large pores.

SURE-SEAL™ LPM PARTICLE SIZE DISTRIBUTION



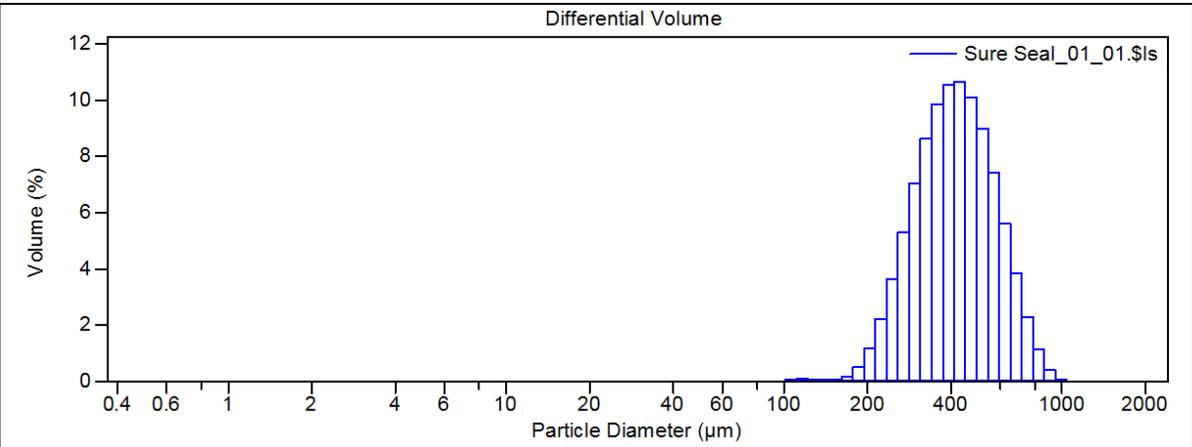
LS Particle Size Analyzer

2 Apr 2009 13:21

— Sure Seal —

File name:	C:\LS13320\Test Data\Lost Circulation Related\Sure Seal_01_01.\$ls		
	Sure Seal_01_01.\$ls		
File ID:	Sure Seal		
Sample ID:	<850um		
Operator:	KDF		
Run number:	1		
Optical model:	Fraunhofer.rf780f		
Residual:	0.90%		
LS 13 320 SW	Dry Powder System		
Start time:	12:50 31 Mar 2009	Run length:	22 seconds
Average Vacuum:	15.5" H2O		
Obscuration:	6%		
Software:	5.01	Firmware:	2.02

Volume Statistics (Arithmetic)		Sure Seal_01_01.\$ls	
Calculations from 0.375 µm to 2000 µm			
Volume:	100%	S.D.:	141.4 µm
Mean:	431.9 µm	Variance:	19992 µm ²
Median:	411.8 µm	C.V.:	32.7%
Mean/Median ratio:	1.049	Skewness:	0.684 Right skewed
Mode:	429.2 µm	Kurtosis:	0.275 Leptokurtic
<10%	<25%	<50%	<75%
266.2 µm	325.8 µm	411.8 µm	519.5 µm
			<90%
			630.0 µm



SURE-SEAL™ LPM EFFECT ON RHEOLOGY

Base Mud – Low Salt

2% NaCl Brine	300 ml
Bentonite	5 g
Rev Dust	30 g
Dristemp	3 g
Driscal D	2 g
Soltex	6 g
Sure Seal	0-66ppb
Barite	for 12.5 ppg

Procedure:

Mixed ingredients in order as listed above. Sheared for 10 minutes.

Measured rheology at 120°F. Measurements performed on FANN 900 with #2 bob.

Rolled for 3 hours at 350°F.

Cooled for 1 hour.

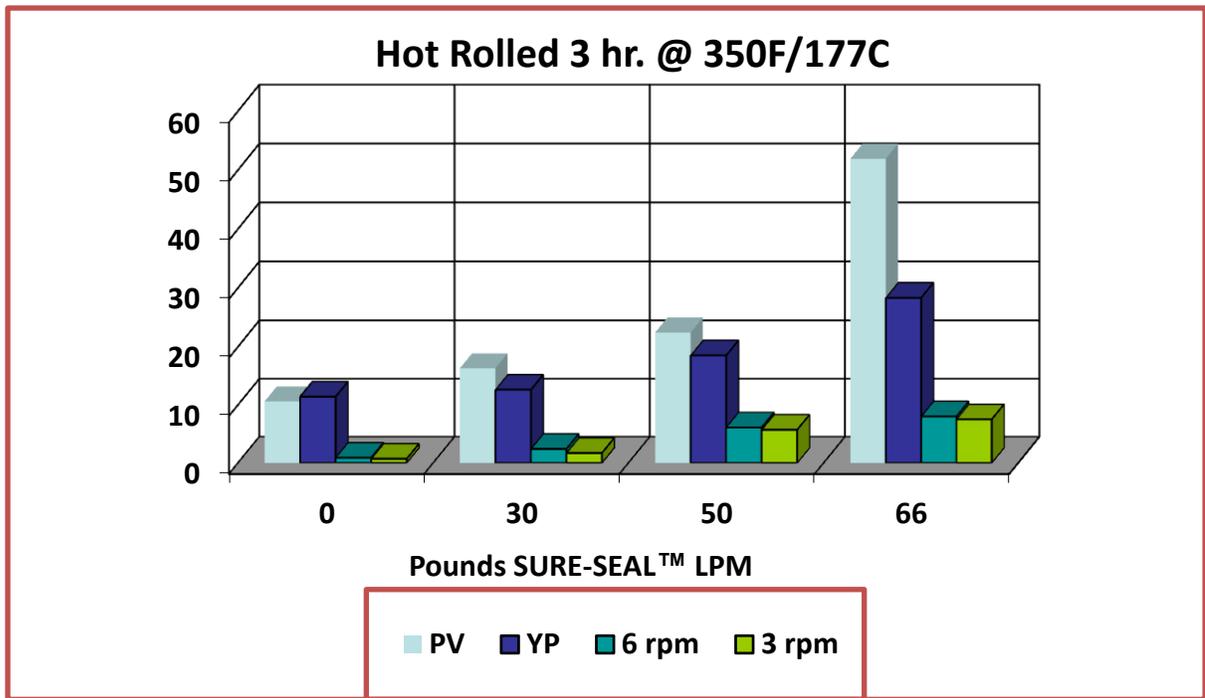
Measured rheology at 120°F. Measurements performed on FANN 900 with #2 bob.

Results:

ppb	<u>0</u>	<u>30</u>	<u>50</u>	<u>66</u>
LCM:				
<u>Initial</u>				
600 rpm	45.9	105	126.9	192.4
300 rpm	32.4	73.5	91.6	137
6 rpm	0.9	13.2	23.2	73
3 rpm	0.7	12.2	19	71.3
PV	13.7	31.5	35.3	55.4
YP	18.8	42	56.3	81.6
Gels	.8/.8	6.6/7.7	10/13.2	52.9/31.1

After Hot

<u>Roll</u>				
600 rpm	32.6	45.2	63.3	132.1
300 rpm	22	28.9	40.9	80.2
6 rpm	0.9	2.4	6.1	8
3 rpm	0.7	1.7	5.7	7.5
PV	10.6	16.3	22.4	51.9
YP	11.4	12.6	18.5	28.3
Gels	.4/1.2	.5/3.4	6.9/8.6	6.2/12.5



SURE-SEAL™ LPM EFFECT ON RHEOLOGY AND ES

Base Mud – Oil Based Diesel

Two aliquots of 10.8 ppg Oil – Based Mud (Diesel) from the field were weighted to 14.0 ppg, and each one was treated with a product as described below in the table below. Each sample was placed in a high temperature cell, pressurized to 100 psi, and hot rolled for 3 hours at 300°F. After cooling, the rheology, ES, and HTHP fluid loss were measured and recorded. Rheology and ES were tested at 120°F. HTHP fluid loss was measured at 250°F and with 500 psi differential pressure.

Property/Sample	Initial Properties	After Hot Rolling	+ Product
OBM ml	350	350	350
SURE-SEAL™ LPM	None	None	30
Barite to 14.0 ppg	As needed	As needed	As needed
600 rpm	24	20	37
300 rpm	20	17	28
6 rpm	8	6.6	9.0
3 rpm	7.8	6.1	8.6
PV	4	3	9
YP	16	14	18
Gels 10sec/10 min	11/24	4/22	12/20
ES	527	531	503
HTHP FL ml	9.2	6.6	11.4

PICTURE OF SURE-SEAL™ LPM



CASE HISTORIES

By Allan Cameron

A major international oil company drilled a well in the North Sea. The drilling fluid was a 12.5 ppg mineral oil mud with 75/25 Oil/Water ratio. 15ppb of SURE-SEAL™ LPM was run in the last few hundred feet in the 8 1/2 " section and coarse shaker screens 10 mesh over 30 mesh were run to maintain LPM concentration in the system. No mud losses were recorded unlike previous wells in the area (very high mud losses previously). At casing point the LPM was screened out with fine shaker screens of 230 mesh. The bottom hole temperature (BHT) was 250° F. The operator was pleased and plans to use SURE-SEAL™ LPM again.

PACKAGING

SURE-SEAL™ LPM is shipped in 50lb sacks 40 sacks to the pallet. Pallet dimensions are 40"X 48"X 46".

ORDERING

Orders may be placed by calling 1-800-423-3985 (Houston, TX) or 832-813-4563 (Houston, TX), or +322-689-1202 (Rotterdam) or 65-6517-3276 (Singapore)

For more information on Drilling Specialties Company products see our web site at www.drillingspecialties.com

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