SOLTEX® ADDITIVE

This paper is a compilation of the writings and thoughts of Wayne Stewart Technical Manager (retired), Bharat Patel Sr. Chemist, Greg Colletti Eastern Hemisphere Sales Manager and Dennis S. Goldwood Sr. Technical Sales Rep Drilling Specialties Company on Soltex® Additive, how it works and how it is genuinely unique as compared to other products.

PRODUCT DESCRIPTION

Soltex® Additive is a sodium asphalt sulfonate made water soluble by a unique sulfonation process. It is a versatile, total mud conditioner that stabilizes shale formations, significantly increases lubricity, lowers HTHP water loss and enhances filter cake properties in both oil and water-based drilling fluids. The product can be mixed in most water-based and all oil-based and synthetic muds.

Soltex® Additive is available in three different forms: Regular, Potassium enhanced and Liquid. Potassium Soltex® Additive is a specially prepared potassium salt of sulfonated asphalt. In addition to providing the same unique qualities as regular Soltex® Additive, it contributes water – soluble potassium ions at approximately 400ppm/lb of product carried in the mud system. This is beneficial in those areas that require the specific action of potassium to adequately minimize water induced clay swelling. Liquid Soltex® Additive is 40% by weight active material in a nontoxic suspension package. For over 40 years, the unique chemistry of Soltex® Additive has delivered extraordinary results in all types of drilling fluids offering the following advantages:

- Reacts with shale to prevent or stop sloughing and swelling
- Significantly increases lubricity; either alone or synergistically with small amounts of oils and synthetics
- Environmentally acceptable - is used on land and offshore
- Extremely temperature stable - does not have the softening point typically associated with un-reacted asphaltic additives
- Minimal and easily distinguishable fluorescence - does not hamper well logging or core analysis
- Will not leave oil slick, sheen or rainbow on water at offshore locations
- No emulsifiers needed to ensure proper mixing
- Do not need to bypass the solids control equipment while mixing

GENERAL INFORMATION

Soltex® Additive is a trade mark product from Drilling Specialties Company, a division of the Chevron Phillips Chemical Company. Soltex® Additive is produced by the sulfonation of asphalt. This sulfonation process produces a product which is highly anionic and is typically over 70% to 80% water soluble. Asphalt is neither anionic nor water soluble. Therefore, after sulfonation Soltex® Additive, no longer has the chemical or physical properties of an, asphalt. In the same way, it is chemically different from gilsonite and blown asphalts which are not sulfonated but are sometimes mistakenly characterized as "Soltex® Additive substitutes".

While the asphaltic and gilsonite materials have some potential to lodge in micro fractures, they are chemically inert. The fact that Soltex® Additive is highly anionic gives it a distinct advantage in seeking out the charged broken edges of shales at the fracture wellbore interface. It seeks out these sites by the same mechanism that anionic water soluble polymers coat the edges of cuttings and the wellbore. Chemically inactive materials such as blown asphalts and gilsonites are only randomly dispersed in the mud. Thus, they contact the fracture face as the mud filters into the micro facture, leaving solids – including the gilsonite and asphalt at the fracture wellbore interface. Evidence of Soltex® Additive's coating action is seen in the need to replace a significant portion of the material in the first 24 – 36 hours after its initial introduction to the system. The concentration is reduced as anionic molecules satisfy available sights on solids and the wall of the bore hole. These phenomena would not be expected with inert materials such as blown asphalts and gilsonites.

The production of Soltex® Additive also gives it a particle size advantage over gilsonite and asphalt. Gilsonite and blown asphalt are ground to size, giving particles that are relatively coarse and quite narrow in particle size distribution. Soltex® Additive being a sulfonated/reacted material, has a wide range of particle sizes ranging from soluble to colloidal to the size one would expect from ground materials. This wide range of sizes provides a high probability of having the proper particle size to fit into the variety of fracture sites. Virtually all Soltex® Additive particles, regardless of size, are highly anionic. When particle size distribution is combined with the fact that the particles are highly charged and therefore seek out the broken edges of shales, it becomes obvious that Soltex® Additive provides a significant advantage over those inert materials sometimes marked as "Soltex® Additive substitutes".

Should potential damage of producing formations be an issue, Soltex® Additive has an added advantage. It is partially soluble in oil and partially soluble in water. Producing fluids will dissolve Soltex® Additive back out of the formation with time. Gilsonites and asphalts are totally insoluble in water and only partially soluble in hydrocarbons and thus have a lower probability of being removed by the flow of produced fluids.

The clay stabilizing characteristic of Soltex® Additive, its ability to lower the HTHP fluid loss and its ability to reduce torque and drag in the wellbore are also excellent reasons to use Soltex® Additive in all water based and oil based drilling fluids.

CHEMICAL DIFFERENCE BETWEEN SOLTEX® ADDITIVE AND ASPHALT OR GILSONITE

Asphalt: Asphalt is a bituminous substance resulting from petroleum by distillation of lighter hydrocarbons and partial oxidation of residue. Asphalt comes out as a bottom from distillation of crude oil in refineries. Asphalt composition depends on the type of crude oil used and the process for its distillation. Asphalt is typically a mixture of:

1. Saturates
2. Aromatics
3. Resins
4. Asphaltene

Gilsonite: Gilsonite is a variety of asphalt that occurs naturally. Gilsonite pitch is a complex combination of hydrocarbons obtained as the raffinate in extract from a solvent extraction of gilsonite. It consists predominantly of a complex combination of olefins, naphthalenes, pyroles, pyridines and other hydrocarbons with a softening point of 80° C to 175° C.

Soltex® Additive: Soltex® Additive is neither asphalt nor gilsonite, it is sulfonated Asphalt, an entirely different product. In the manufacture of Soltex® Additive, specially selected asphalt is use as a raw material. The sulfonation of asphalt can be simply shown as:

Asphalt + sulfonating agent → Sulfonic acid of asphalt
Sulfonic acid of asphalt + NaOH → Sodium asphalt sulfonate (Soltex® Additive)
Sulfonic acid of asphalt + KOH → Potassium asphalt sulfonate (Potassium Soltex® Additive)

It should be pointed out that all available double bonds from hydrocarbons are eliminated by the sulfonation process used to make Soltex® Additive. An excess amount of sulfonating agent is used to guarantee the complete sulfonation and smooth processing in the plant. This process is routinely monitored by testing the solubility of Soltex® Additive and Potassium Soltex® Additive in water.

COMPARISON OF SOLTEX® ADDITIVE, ASPHALT, AND GILSONITE
TABLE I

Analysis	Soltex® Additive	Asphalt*	Gilsonite
Loss on Ignition, wt %	36.3	72.8	99.2
Softening Point	None	50° C – 150° C	80° C – 175° C
Carbon, wt %	49.0	87.2	86.6
Hydrogen, wt %	4.6	9.4	8.0
Nitrogen, wt %	0.5	0.8	2.6
Sulfur, wt %	11.1	1.8	0.5
Oxygen, wt %	34.8	0.8	2.3
Solubility in water, %	>70	<1	<1

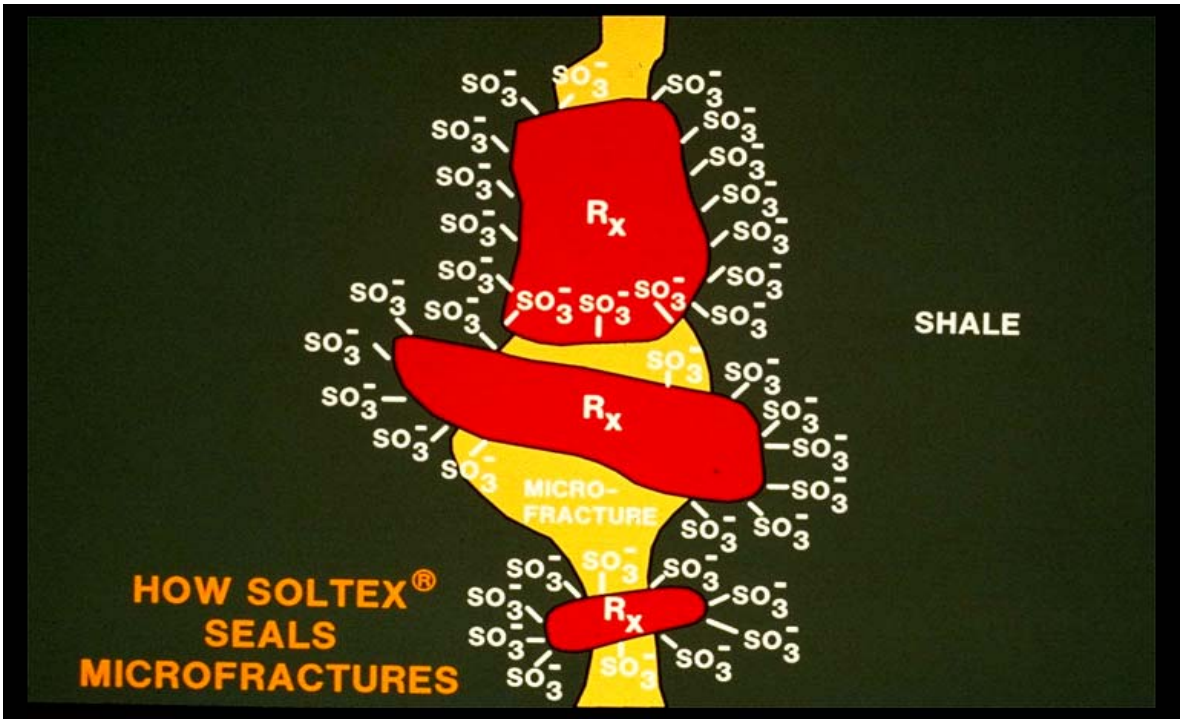
* Analysis of asphalt before sulfonation in the manufacturing of Soltex® Additive.

The above comparison shows that there are two easy tests that anyone can perform that should convince them that Soltex® Additive is neither asphalt nor gilsonite. One is to demonstrate the solubility in water, see photo on page 6. The other is to place about one-gram samples of each on a hot plate side-by-side, and turn the hot plat on maximum for 10-30 minutes. The asphalt and gilsonite will melt while Soltex® Additive will not. At temperatures above 300° F, Soltex® Additive partially sublimes, but weight loss is less than 10% in an hour at the highest temperature, most hot plates can attain. Asphalt and gilsonite will have almost complete weight loss.

SOLTEX® ADDITIVE VS BLOWN ASPHALT

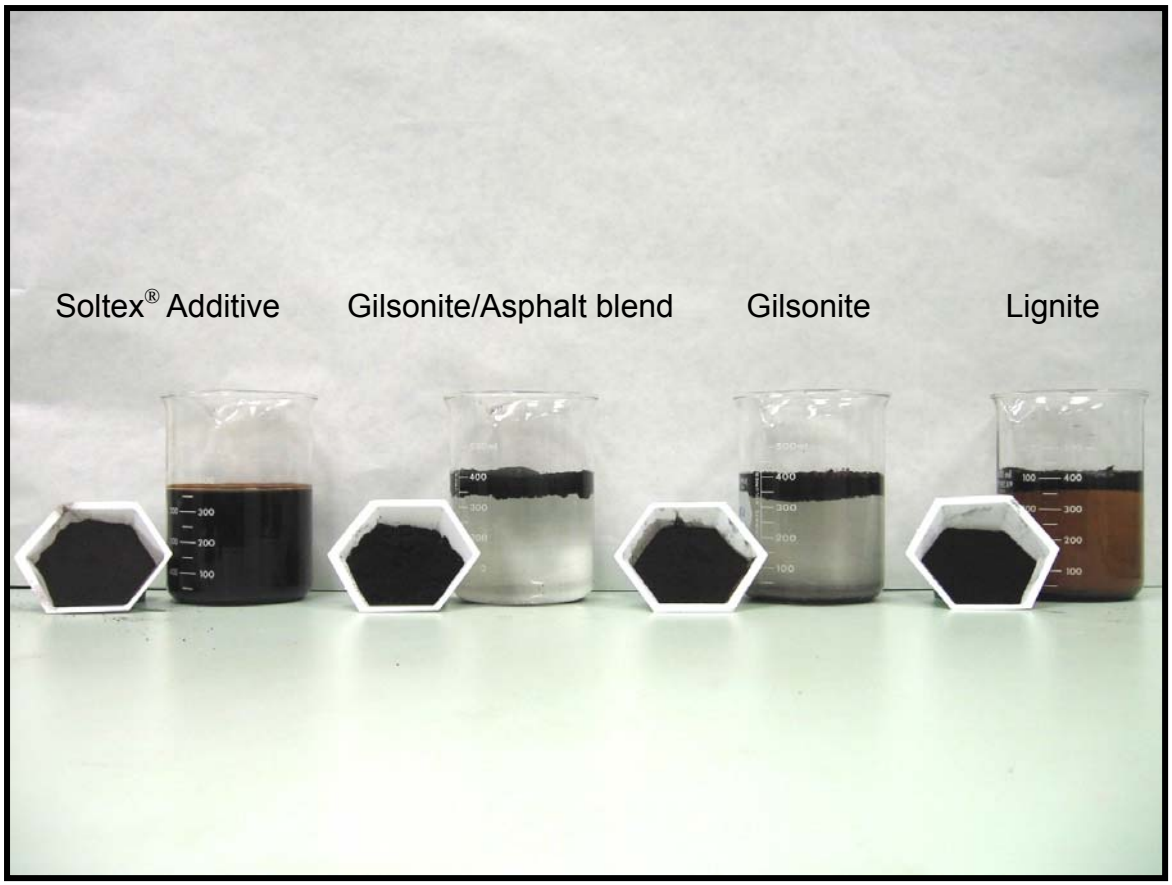
Blown asphalt is made by a process of blowing hot air through melted asphalt. This process oxidizes and purges out low ends (low molecular weight materials). It probably also oxidizes any reactive sites on the higher molecular weight materials. The result is an increase in the softening temperature. Raising the softening temperature makes the material more friable and easier to grind.

Soltex® Additive is produced by reacting asphalt with SO_3. The SO_3 reacts with available double bonds. This creates chemically altered sulfonated material. It is then neutralized with sodium or potassium hydroxide. This process gives a material that is highly anionic (has a negative charge). It is also partially soluble in water. Particle size ranges from very small (about 10 carbon atoms – much too small to see) to very large (highly charged particles large enough to see with the unaided eye). This large variation in particle size range gives a high probability of having particles the correct size to plug holes in both rock and wall cake. The anionic character also gives it an affinity for broken rock and clay edges which are charged sites. See illustration below.



Blown asphalt has no chemical charge. It is not soluble so its particle size is strictly related to how finely it is ground. Typically it is ground to something between 50 – 200 mesh. This would be equivalent to the largest particles in hydrated and dispersed Soltex® Additive. Any “solubility” seen in blown asphalt is not solubility of the blown asphalt, but rather something that is blended with it, usually lignite. Blown asphalt is not soluble in water. In fact it has to have a

surfactant blended with it to keep it from floating out. Blending a sulfonated surfactant with blown asphalt does not create sulfonated asphalt. It just reduces the surface tension of the water enough that the surface of the asphalt is water wet and it does not float out. The photo below shows that asphalt, Gilsonite/Asphalt blends and Gilsonite all float on fresh water. If it floats on water it will float on a drilling mud! Lignite mixes better but mostly floats until you raise the pH. Most look-a-like products have a large lignite component with pH material added to simulate the appearance of being sulfonated. Another reason to add lignite is that it is cheap and readily available.



SOLTEX® ADDITIVE COMPARED TO GILSONITE

There are presently no true substitutes for Soltex® Additive because the chemical modification of asphalt by sulfonation requires special equipment, selected asphalts, and considerable expertise. This sulfonation process produces a product which is highly anionic and is typically 70% to 80% water soluble. Therefore, after sulfonation Soltex® Additive, no longer has the chemical or physical properties of asphalt. The water – soluble portion of Soltex® Additive is comprised of large, electronegative macro molecules. These particles in the filtrate bond themselves to the electropositive edges of clays and shales. This chemical neutralization inhibits the natural tendency of the formation to take on water. Thus, sloughing, swelling and shale disintegration are prevented.

The fact that Soltex® Additive is highly anionic gives it a distinct advantage in seeking out the charged broken edges of shales at the fracture well bore interface. This neutralizes the broken edges and prevents water from entering the formation. Chemically inactive materials such as gilsonite are only randomly dispersed in the mud. Gilsonite contacts the face as the mud filters into the micro fracture, leaving solids, including the gilsonite at the fracture wellbore interface.

The production of Soltex® Additive also gives it a particle size advantage over gilsonite, which is ground to size, giving particles that are relatively coarse similar to those of ground asphalt mentioned above. Virtually all Soltex® Additive particles, regardless of size, are highly anionic. When particle size distribution is combined with the fact that the particles are highly charged and therefore seek out the broken edges of shales, it becomes obvious that Soltex® Additive provides a significant advantage over products like gilsonite.

Soltex® Additive excels in controlling fluid loss, and especially high temperature high pressure (HTHP) fluid loss. The Soltex® Additive in the filtrate is inhibitive and minimizes damage to water – sensitive shales and drilled cuttings. In lab tests gilsonite appears to be ineffective in reducing HTHP fluid loss of a drilling fluid and in some tests has actually increased the HTHP fluid loss over the control as documented in the "Liquid Soltex® Additive Technical Paper".

The clay stabilizing characteristic of Soltex® Additive, its ability to lower the HTHP fluid loss, its ability to increase lubricity, prevention of bit balling, reduce torque and drag, and help prevent differential sticking are all reasons to rely on Soltex® Additive. The special combined chemical and physical activity of Soltex® Additive clearly accounts for its superior performance.

Soltex® Additive goes into a drilling fluid and remains stays there because it is sulfonated. Non – reacted competitive materials, such as gilsonite and blown asphalt need a surfactant to keep them from floating out. Further, the non-reacted materials will agglomerate if any oil or hydrocarbon condensate is present in the system, and that will cause them to float out on the surface of the pits or go out over the shaker taking good materials like polymers with them. This costly loss of additives can be avoided when Soltex® Additive is used.

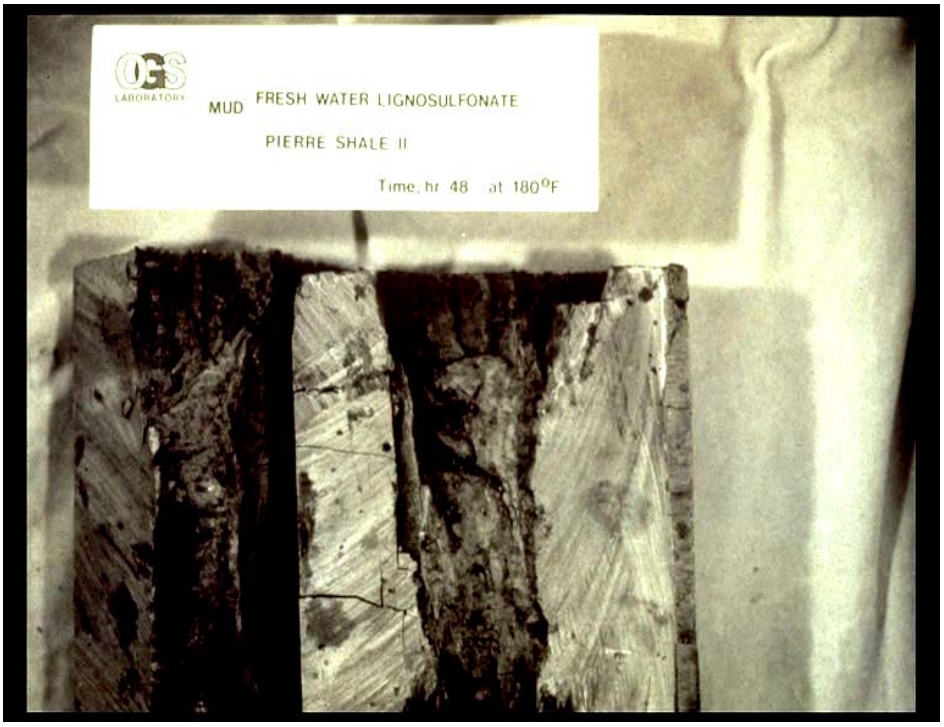
SOLTEX® ADDITIVE AND SHALE STABILIZATION

The following pictures were taken from a report commissioned in 1990 to compare Soltex® Additive to gilsonite and determine which was better at shale stabilization. The core test work, conducted by O.G.S. Labs then an independent laboratory sets a new standard in determining borehole stability. This method utilized the "Down-hole Simulation Cell" (DSC) and more nearly simulates down-hole conditions when compared to other test methods. The pictures provide the first laboratory evidence the drilling industry has had, to support almost 50 years

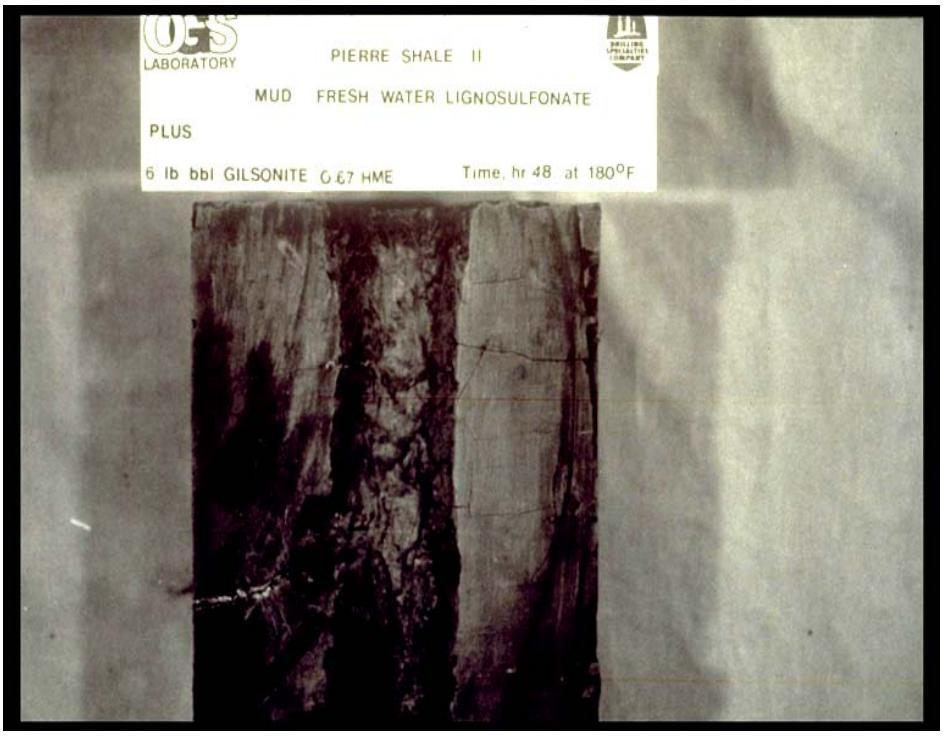
of case histories all showing Soltex® Additive to be an excellent shale stabilizer. The mud system used was a fresh water lignosulfonate mud system with test duration of 48 hours and a test temperature of 180° F. The mud treated with Soltex® Additive had less than 10% hole enlargement, the gilsonite treated mud had 53 % compared to 100 % hole enlargement for the control mud. Both test muds were treated with 6 ppb of product, 0.67 % HME (an oil wetting agent) was added to the gilsonite treated mud to make the gilsonite dispersible and is standard procedure.

MUD PRESSURE:	3,400 psi
OVERBURDEN PRESSURE:	3,400 psi
CONFINIG PRESSURE:	3,100 psi
FLOW RATE: CIRCULATING	1.2 GPM
FLOW RATE: DRILLING:	1.7 GPM
ANNULAR VELOCITY:	52.3 FT/MIN - CIRCULATING GAUGE HOLE
ANNULAR SHEAR RATE:	502.1 1/SEC - CIRCULATING GAUGE HOLE
SPECIMEN DIMENSIONS -	
OUTSIDE DIAMETER:	16.2 cm
LENGTH:	20.3 cm
BIT SIZE:	3.2 cm
BIT TYPE:	2 CONE MILLTOOTH
ROTARY SPEED:	60 RPM (DRILLING)

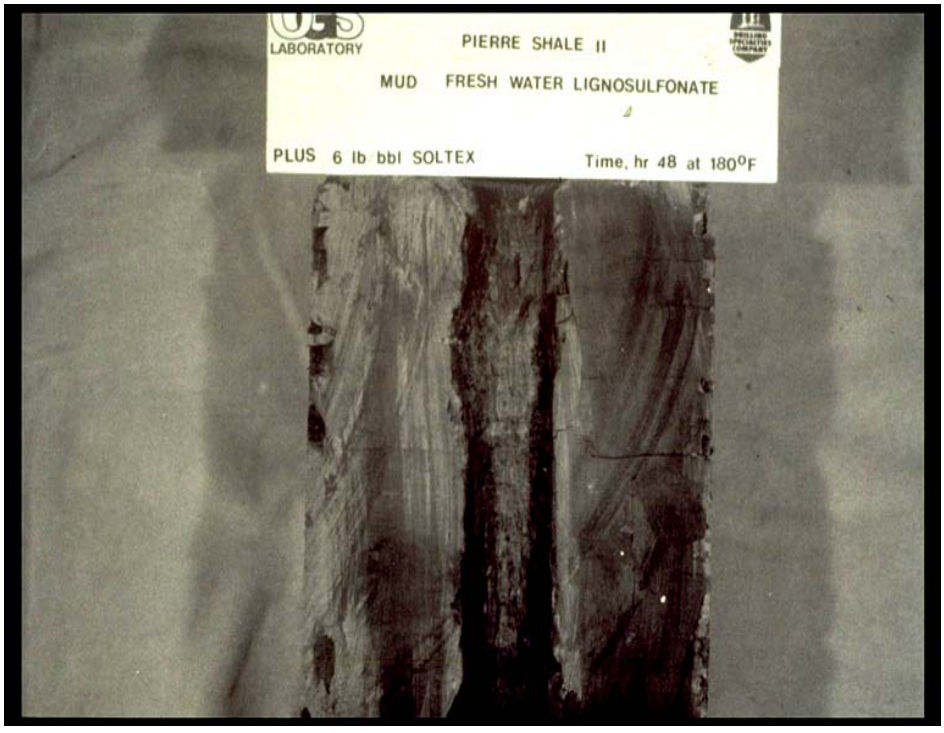
PIERRE SHALE II DRILLED WITH 3.2 cm MICRO BIT WASHED OUT TO 6.4cm 100 % HOLE ENLARGEMENT



PIERRE SHALE II DRILLED WITH 3.2 cm MICRO BIT WASHED OUT TO 4.9cm 53 % HOLE ENLARGEMENT TREATED WITH 6 PPB GILSONITE



PIERRE SHALE II DRILLED WITH A 3.2 cm MICRO BIT WASHED OUT TO 3.5cm, <10 % HOLE ENLARGEMENT TREATED WITH 6 PPB SOLTEX® ADDITIVE



QUICK REFERENCE GUIDE FOR APPLYING SOLTEX® ADDITIVE

Application	Material Needed	
	Soltex® Additive Regular & Potassium	Liquid Soltex® Additive drums/100 bbl
Stabilize shale formations	3 to 6 ppb (9 to 17 kg/m^3)	1.0 to 3.0
Impart lubricity	1 to 3 ppb (3 to 9 kg/m^3)	0.5 to 3.0
Reduce torque & drag	1 to 3 ppb (3 to 9 kg/m^3)	0.5 to 1.5
Control HTHP fluid loss	2 to 6 ppb (6 to 17 kg/m^3)	1.0 to 3.0
Thin, strong, compressible wall cakes	2 to 4 ppb (6 to 11 kg/m^3)	1.0 to 2.0
Emulsify oil into water-based mud systems	0.5 to 3 ppb (2 to 9 kg/m^3)	.25 to 1.5
General hole conditioning (differential sticking, etc.)	2 to 6 ppb (6 to 17 kg/m^3)	1.0 to 3.0

MIXING GUIDELINES

If excessive product losses are being experienced over the shakers, it is recommended to employ coarser screen sizes during initial stages of product addition, and then switching over to finer sizes. It is not uncommon to experience a 10 to 20% loss over shakers during initial stages of additions, and in some areas may be considered normal and within acceptable limits.

Soltex® Additive solubility is much dependent upon temperature, and circulation time. Soltex® Additive will more rapidly mix into the mud system as the fluid temperature increases. If the mud is very cool, it may be best to hold off additions until it has a chance to warm up. An amount of Dilution may also be required during initial additions. Continual additions of Soltex® Additive will be needed to maintain a sufficient concentration in the system if losses occur while drilling. Soltex® Additive is consumed while depositing on drilled solids and on the well bore. It is advisable to add 50% more, one day following the initial treatment, to ensure adequate concentration. Use a conventional hopper when chlorides do not exceed 60,000 ppm. When adding to high salinity systems, pre-wetting the Soltex® Additive with fresh water by adding through a chemical barrel or pre-mix tank will improve results.

PRE-MIXING

Asphalt materials (including Soltex® Additive), may have some preliminary losses over the shaker. Precautionary actions to eliminate or reduce this possibility may be necessary. Pre-mixing is recommended even if the product is not running over the shakers, as the thorough solubility before mixing with whole mud, leads to better hole stability. If Soltex® Additive cannot be added directly to the system through the hopper, it can be added to the system using a chemical barrel or pre-mix arrangement. Add 40-50 ppb of Soltex® Additive to either the base oil or to the base mud and then bleed it into the active system. Agitation, stirring or circulation may possibly be required in the pre-mix tank or chemical barrel to prevent excessive settling. Pre-mixing in freshwater is recommended as the best method, even when adding to an oil base mud system. Make up salt such as calcium chloride can be added to the pre-mix, but this is usually not necessary as the amount of fresh water added to the system via concentrated pre-mix solutions will be negligible.

PRE-MIXING IN FRESHWATER

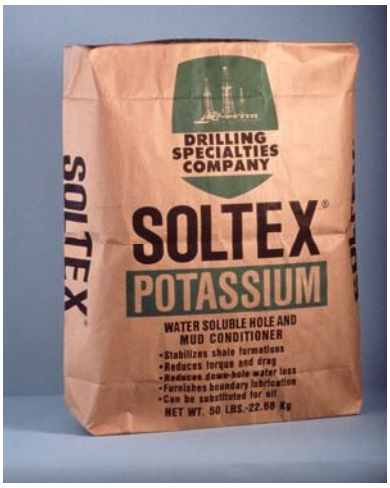
Mixing in freshwater might be the simplest and cheapest solution. Mix 40-50 ppb of Soltex® Additive in a slug pit of freshwater. There could be some foaming, so if the mixing system requires, a defoamer may be added to prevent surface foam.

PRE-MIXING IN OIL BASE MUDS

An alternate solution is to solubilize Soltex® Additive in base oil. If this option is desired over freshwater, then premixing 40-50 ppb into the smallest volume of base oil as possible prior to bleeding over into the active system is extremely effective. In most offshore environments the use of diesel is forbidden and can be detected using analytical methods, and if discovered, none of the cuttings can be put overboard. However, in some land operations when permitted, a small amount of diesel can be used to pre-mix Soltex® Additive. If used sparingly, it becomes only slightly detectable after incorporation into the whole system. Of course Soltex® Additive may be mixed in other hydrocarbons such as mineral oil, and synthetic oils.

SOLTEX® ADDITIVE PLANT

There are presently no true substitutes for Soltex® Additive because the chemical modification of asphalt by sulfonation requires special equipment, selected asphalts, considerable expertise and a plant to make it. There is only one Soltex® Additive plant in the world. The next time someone tells you it is sulfonated asphalt just like Soltex® Additive ask for a trip to their plant or at least a picture of one. The Drilling Specialties Company plant is located just east of Conroe, Texas. To arrange for a tour of the plant call your local Drilling Specialties Co. representative today. Qualified customers only! For more information visit us at our web site at www.drillingspecialties.com.



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