P-LFS & P-LFS2

CEMENTING SERVICE BULLETIN

04/18/96

P-LFS & P-LFS2 (PETROCHEM-LAMINAR FLOW SPACER)

TECHNICAL DATA

P-LFS is a water based laminar flow spacer fluid designed for use at bottom-hole temperatures below 302°F (150°C) and to be pumped ahead of the cement slurry. The spacer separates the cement slurry from the drilling fluid and is designed to be compatible with both the slurry and the water/oil-based drilling fluid.

The normal concentration range of P-LFS is between one (1) to two (2) pounds per barrel, from 12 lb/gal to 22 lb/gal respectfully. P-LFS can be used in fresh water or salt/seawater spacers up to 5% salt BWOW. Above 5% salt BWOW, the efficiency of P-LFS is impaired. Therefore in spacers containing above 5% salt BWOW up to saturated salt water the use of P-LFS2 is required. When P-LFS or P-LFS2 is pre-hydrated in salt water systems, the salt must be added after the complete hydration of the P-LFS/P-LFS2.

After hydration, add the weighting agent and/or loss circulation material if needed. Ideally, the spacer is designed to be of a higher density and viscosity than the drilling mud. The spacer is easily moved in laminar flow effectively displacing the drilling fluid.

P-LFS is compatible with most water based muds. However, compatibility tests with the mud and cement are recommended prior to the job. If the P-LFS/P-LFS2 is to be used with *oil base mud*, the addition of P-NSL2 (Petrochem non-ionic surfactant) is required at a concentration between one (1) to two (2) gallons per barrel of spacer, to render the spacer compatible with the oil base mud.

A minimum of 500 feet of annular fill or 10 barrels of spacer, whichever is greater is recommended. A good guideline to use is 2 barrels per foot of depth. Increased temperature will thin the spacer fluid but will not cause the gel structure to break subsequently the system will continue to support solids at elevated temperatures.

When weighting up the spacer use a course grind material to avoid excess viscosity, but at densities above 18ppg consider using Hematite or a mixture of Barite and Ilmenite.

P-LFS/P-LFS2 may be dry blended with the weighting agent and/or loss circulating material (if needed) or pre-hydrated in the mix water. The mixing equipment used for pre-hydrating must be clean, in particular, from mud contamination. Use P-DAL (Petrochem Defoamer and Antifoam Liquid) in place of P-AFAL. If salt is to be used, it must be added after the complete hydration of the P-LFS/P-LFS2. Do not pre-hydrate the P-LFS/P-LFS2 for more than a few hours before the job, otherwise a bactericide may be required.

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Field mixing procedures:

Circulate the P-LFS/P-LFS2 at a high rate for 20 to 30 minutes (more in sea/salt water) to complete the additive hydration. The sequence of the addition of the additives should be the same as that used in the laboratory.

The data given is to be used only as a guide. Subsequently, each job is to be designed and tested in the laboratory prior to the job.

PROPERTIES

PRODUCT	FORM	SP.GR.	PACKAGING
P-LFS	WHITE POWDER	2.53	50 LB/SACK.
P-DFL	WHITE LIQUID	1.00	55 GAL/DRUM.
P-NSL2	CLEAR LIQUID	1.06	55 GAL/DRUM

SAFETY

Consult all MSDS before using these materials.

Calculation for the Preparation of the P-LFS Spacer:

To calculate the amount of mix water, P-LFS, weighting agent etc. needed for the preparation of the P-LFS spacer, use the following procedure:

1. Calculate the amount of base fluid (containing the P-LFS and optionally NaCl) needed to give the required volume of spacer P-LFS. This volume of base fluid is less than the volume of the spacer because the increase in volume, caused by the addition of the weighting agent, has to be taken into account. The following formula can be used:

Eq. 1

$$Vbf = Vs \frac{(Sb - Ss)}{(Sb - Sbf)}$$

Where:

Vbf= volume of base fluid (in m3),

Vs= desired spacer volume (in m3),

Sbf= SG of the base fluid, can be taken as the SG of the base fluid without P-LFS (= 1.00 if no NaCl is added, 1.03 if seawater is used, 1.11 if 18% NaCl is added and 1.17 if 30% NaCl is used),

Ss= desired spacer SG, and

Sb= SG of weighting agent (4.33 for Barite, 4.95 for Hematite or 2.7 for $CaCO_3$).
The specific gravity of the weighting agents has to be checked in the laboratory.

2. The amount of mix water and P-LFS needed to produce the required volume of base fluid can be calculated as follows.

Where:

Mbf = mass of base fluid (= mass of water + mass of P-LFS + mass of NaCl) in metric tons,

Sbf = SG of base fluid can be taken as equal to SG of water + NaCl,

Mw = mass of mix water (in metric tons),

Vw = volume of mix water (in m3),

Sw = SG of mix water (= 1.00 for fresh water, 1.03 for seawater),

CS = concentration of NaCl (expressed in % BWOW) (if no NaCl is to be added to the spacer,CS = 0),

Ms = mass of NaCl (in metric tons),

MP-LFS = mass of P-LFS powder (in kilograms), and

C= the P-LFS concentration (in kg/m3).

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3.Calculate the amount of weighting agent:

Eq. 2

Mb = (Vs - Vbf) X Sb ,

Where:

Mb = mass of Weighting Agent Barite, Hematite or $CaCO_3$ (in metric tons).

Sample Spacer; WITH GIVEN:

Mud Density: 13.3 lbm/gal (1.60 SG)

Mud Viscosity at BHCT: FANN reading at 100 rpm (Spring 1): 48

Cement Density: 15.8 lbm/gal (1.90 SG)

Cement Viscosity at BHCT: FANN reading at 100 rpm (Spring 1): 80

BHCT: 122°F (50°C)

Annulus: 12.5-in. open hole, 9.625-in.casing

SAMPLE CALCULATIONS:

1. The required spacer density is chosen halfway between 13.3 and 15.8 - 14.5 lbm/gal (1.74 SG).

2. The required spacer FANN reading at 100 rpm will be halfway between 48 and 80 - 64.

3. A laboratory mixture of the P-LFS spacer (with the weighting agent and mix water to be used on location) gave a 100 rpm reading at 122°F (50°C) of 80.

4. The required spacer volume for 500 ft of annular fill (12.5 - 9.625 annulus) is 31 bbl. Since this is less than the recommended minimum value of 60 bbl, use 60 bbl as the required spacer volume (9.54 m^3).

5. Use Eq. 1 to calculate the required amount of base fluid to finish with 9.54 m3 of spacer (this includes the volumes of the mix water, P-LFS and weighting agent)

Eq. 3

$$V_{bf} = 9.54 \frac{(4.33 - 1.74)}{(4.33 - 1.00)} = 7.42 \text{ m3}$$

Therefore, 7.42 m3 of base fluid (water + P-LFS) has to be prepared.

8. According to Eq. 3, 7.42 m3 of base fluid with P-LFS requires 7.27 m3 of fresh water (45.7 bbl).

9. From Eq. 2 calculate the amount of barite required:

(9.54 - 7.42) x 4.33 = 9.18 metric tons (20,230 lb).

10.Approximate to nearest field units:

Fresh Water: 46 bbl

Barite: 9.18 tons or 183 sk of 50 kg.

Mixing Procedures for the P-LFS Spacer

1. Add Antifoam Agent P-AFAL, P-DFL or P-DAL to the required quantity of mix water, typically in the range of 0.1 to 0.2 gal/bbl (2 to 4 L/m3). P-DFL is the preferred antifoam agent if high NaCl concentrations are used.

2. Cut open the sacks of P-LFS into the mixing hopper. If a TORNADO mixer is used, a small hopper should be built to fit on the cement feed line and the P-LFS added through this line. The spacer concentrate is then mixed and re-circulated until all of the components have dissolved, which takes about 10 to 20 min or if there is a choke in the recirculation line. If there is no choke in the line, one to two hours is needed, depending on the mix-water quality (longer for seawater or very brackish water).

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Although not recommended, the direct addition of the spacer concentrate to the slurry tub or the mix-water tank is possible provided that sufficient recirculation is present and that enough time is given for full hydration. Some lumps could be formed and they should be broken by hand or by increasing the circulation rate, to allow full hydration. Agitation with a paddle alone will not lead to sufficient hydration.

For offshore operations, when mixing in the slug pit, the mud hopper can be used provided that lines and equipment have been thoroughly cleaned and are perfectly free from any residue.

To check if hydration of the spacer concentrate is complete, the viscosity of this base fluid can be measured (either with a FANN viscometer or with a Marsh funnel) and compared with the viscosity of a sample prepared in the laboratory.

3. If needed, the required amount of NaCl is added to the spacer solution. Recirculation is continued for at least 30 min to allow for complete dissolution of the salt. To minimize the formation of foam, the recirculation rate should be lowered before addition of the NaCl. If foaming occurs during the addition of NaCl, P-DFL can be added. P-DFL is an efficient defoamer.

4. Add the required amount of weighting agent and mix for an additional 10 min. The weighting agent should be added directly into a point of significant agitation, i.e., into the hopper of the mixer or vortex of the paddle tank.

When using a TORNADO mixer, the best way is to directly blow the bulk barite into the spacer base fluid through the cement feed line. Never add the weighting agent before the base fluid is ready, with P-LFS fully hydrated and salt (if any) completely dissolved.

At this point, the density of the spacer should be checked, because the actual density of the weighting agent used in the field can be somewhat lower than the theoretical density used for the calculations. If needed, add some extra weighting agent.

JOB DESIGN DATA FOR THE P-LFS SPACER COMPATIBILITY:

Compatibility with both cement and mud is the most important property of any spacer. There are obviously many different ways of conducting compatibility tests, because the separate fluids can be first prepared and then mixed together using different techniques. These include mixing with a Waring blender for a short period of time, using hot or cold fluids, homogenization with a spatula for a long period of time, etc....

To prevent problems, the API has developed a procedure described in API Specification 10, Appendix P, 4th edition (August 1988), for preparing and testing samples, which was used to generate data presented in this technical manual section. This is a good method to use because it allows data to be compared from one area to another and leads to reproducible results. Above all, it is the nearest to a worldwide accepted technique.

Two fluids are said compatible if they are "capable of forming a homogeneous mixture that is stable and is not undesirably altered by chemical reaction." Thus, common sense has to be applied in deciding what are called compatible or incompatible fluids. Different, and in some cases wildly erratic compatibility results, will be obtained if the API procedure is not followed.

However, and although not specified in the API procedure, it has been observed that incompatibility can sometimes be detected by also measuring the 10-min gel strength of the mixtures at BHCT, even if no incompatibility is detected through the dynamic readings.

As a consequence, the Petrochem recommended compatibility testing procedure is the following –

1. Preparation of the Fluids: for cement slurries, use the API Specification 10, Section 5; for spacer, use the method described in Laboratory Preparation above; and for muds, get samples from the rig.

2. Preparation of the Mixtures: use API Specification 10, Appendix P.

3. Testing: run the API recommended tests, taking the FANN readings at 3, 6, 30, 60, 100, 200 and 300 rpm. Also the 10-min gel strength at BHCT should be recorded (peak reading at 3 rpm after 10-min static in the FANN cup and the reading after one minute of rotation at 3 rpm).

The P-LFS spacer shows excellent suspending properties, there is no settling of weighting agent, both under static conditions and under moderate shear, provided that the spacer concentrate has been hydrated following the procedures described in this manual section. There is no free-water development at room temperature or at BHCT.

After a free-water test of two hours, the density of the spacer at the bottom of the cylinder is still the same as the density at the top.

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