Soap Sticks - Best Practices

Pro-Seal Lift Systems, Inc.

'Artificial Lift Innovation'

Soap Sticks Usage - Best Practices

Topics

- Soap Sticks – How do they work?
- Creating Mist – Surfactant Dissolution
- Conditions within the Tubing
- Placing Surfactants – Resident Time
- Quantity Preferences
- Flow Control – Yes / No
- Launch Delay Explained
- Automatic Soap Stick Launchers
- High Line Pressure Applications
- ‘Rule of Thumb’ Surfactant Schedule
- SCADA options
- Limitations

How Do Soap Sticks Work?

- As an aging well advances down the natural decline curve, formation liquid within the tubing retards the free flow of gas to the surface.

- Surfactants (soap sticks) dissolved in this liquid act to reduce the surface tension between the molecules of water from the formation.

- With limited surface tension, the formation water is more easily broken into smaller droplet sizes (mist).

De-Watering the Production String

- Our goal is to create a mist from the uppermost part of the liquid column that is retarding the free-flow of gas to the surface;
- When de-watering with surfactants, the uppermost barrel of liquid is the easiest to remove from the tubing;
- Soap sticks, surfactants in solid form, are ideal for this task.

Flowing Mist to the Surface

Smaller H_2O groupings, mist, exhibit high surface area to weight ratio – similar to clouds.

Mist in suspension

These moisture laden clouds float on an uplift of warm air demonstrating that smaller droplets can be *carried* on a column of upflowing gas.

Surfactant Dissolution

The goal is to create mist. ***How?***

The preferred conditions for dissolving a soap stick are:

- **Presence of water**
- **Elevated temperature**
- **Potential for agitation**

Where can each of these conditions be found together?

Conditions within the Tubing

Favorable conditions at the top of the water column:

- Less hydrostatic head, bubbles releasing from entrainment
- Roiling liquid in the upper reaches of the column
- Larger gas spheres breaking and escaping from the surface of the water column

These bursting gas bubbles, at the **top** of the water column, are the energy source for the creation of mist from the combination of water and surfactants.

Contrary conditions at the bottom of the water column:

- Entrained gas held within liquid under pressure
- Free gas spheres of minimal size due to the greater hydrostatic head near the bottom of the water column
- Non-turbulent movement of liquid upwardly

Placing Surfactants, part I

Methods for placing surfactants within the production tubing:

i. Dropping one or more solid surfactant sticks
ii. Injecting freshwater and surfactant below the tubing
iii. Batch treatment: a freshwater/surfactant mixture

- ❖ Batch treatments are interventive - the effects are of limited duration and the treatment requires a lost-production shut-in;
- ❖ Capillary injection places the pre-diluted surfactant in a non-turbulent zone, unnecessarily increasing surfactant resident time; (see Slide 10)
- ✓ Surfactants in solid form, dropped from the surface, will mix with the water in the most turbulent zone of the column.

Placing Surfactants, part II

Dissolve Time for Solid Surfactant?

- Soap sticks fall at ~3000'/minute but descend much more slowly in the water column;
- When properly landed at the top of the water column, the soap sticks will begin the dissolving process immediately;
- As it loses mass, the soap stick quickly loses its descent rate through the water column.

Placing Surfactants, part III

Surfactant Resident Time

- All chemical reactions take place over time;
- The longer the surfactant is in the presence of water and hydrocarbons, the greater the rate of water-surfactant-hydrocarbon bonding (not good);
- The water-surfactant-hydrocarbon grouping is heavier than a mist of water-surfactant only;
- Water treated at the bottom of the water column requires considerably more surfactant due to this resident time (Slide 8).

Therefore, the best practice is to place the surfactant at the top of the water column.

Column Weight vs. Gas Expansion

(from Slide #4) *"The object is to remove the uppermost barrel of liquid from the top of the column."*

Mist-flowing ~1 barrel of water to the surface lightens the load against the formation by ~100psi (2-3/8" tubing).

The removal of the weight of one barrel of liquid from the top of the water column causes each small gas sphere further down in the water column to expand, reducing the effective density of the remaining liquid.

Soapstick Quantities

How many sticks per barrel?

Rule of thumb: 1 soap stick has enough active ingredient to dilute 1 barrel of formation water.

If 1 stick is good, aren't 2 sticks better?

One barrel equivalent of mist weighs ~100psi. Launching 2 or more sticks (~200psi) can overwhelm the available gas rate and/or gas pressure of low volume, low pressure producers.

How many sticks per application?

The preference is for the tubing to receive just 1 stick only – as frequently as called for by the reaction of the well. (exceptions do apply)

Flow Control and Surfactants

Continuous flowing conditions are preferred:

- A soapstick will dissolve in the top of the water column if the well is allowed to flow while the stick is falling;
- A soapstick will not fall past the wing-block at a rate above 300 MCFD in 2-3/8” tubing
  (500 MCFD for a 2-7/8” wing-block)
  (700 MCFD for a 3-1/2” wing-block);
- A soapstick will continue to descend against a 1000 MCFD rate (2-3/8” tubing) once it is below the wing-block capture zone.

Flow Control

Shut-in the wing valve, yes / no?

Three reasons to shut-in a flowing well during the launch of a soapstick:

- Poor performer (less than critical rate)
- High gas rate (above 300 MCFD, 2-3/8″) (Slide 13)
- High liquid rate (above 25 BLPD, 2-3/8″)

Shut-in for how long?

Duration of Shut-in

- Poor Performer: Shut-in until tubing reaches 100# above line pressure. Do not exceed 300# above line pressure when using a canister-style automatic SoapStick Launcher.
  (see Slide 20, *Launchers for high line PSI*)

- High Gas Rate: Shut-in for ~30 seconds – just long enough for the soapstick to fall below the wing-block. (see *Launch Delay*)

- High Liquid Rate: Shut-in for ~60 seconds, just long enough for the liquid flow to settle down. (see *Launch Delay*, Slide 16)

- Poor Performer with High Liquid: Shut-in until tubing pressure is 100-300# above line psi.

Launch Delay Preferences

- When the gas rate is below 300 MCFD and the liquid rate is below 25 BLPD, a soapstick may be launched while the well is flowing (2-3/8" wing block flow tee).

- When the well is shut-in, the preference is to *delay* the drop of the soapstick until *30 to 60 seconds prior to the re-opening* of the flow control valve, to prevent an excessive descent.

- When a soapstick is dropped into a flowing or non-flowing well, the stick reaches the top of the water column in 60 to 180 seconds. After an additional 180 seconds, the stick is 1000 feet below the top of the water column, deeper than preferred. (review Slide #10 '*Surfactant Resident Time*')

- Soapsticks sent to the rat-hole do not effectively mix with the formation water in the target zone, i.e. the upper reaches of the water column.

Automatic SoapStick Launchers

- Automatic SoapStick Launchers are employed to launch soapsticks on a timed schedule to match the inflow of formation water into the tubing (all Models);
- The Model 9P and 18P SoapStick Launchers can be programmed to close and open a pneumatic flow-control valve in the flowline in concert with the stick launch;
- Models 9E, 18E, 9EE and 18EE can close/open an ABV (12v actuated ball valve) in the flowline;
- Automatic Launchers can be programmed to *delay* the launch of the soapstick until just prior to the valve re-opening;
- Automatic Launchers can launch multiple soapsticks at once for those locations that can support a heavy surfactant charge (Models P and E only);
- Soapsticks, deployed correctly into a casing-only completion, can delay the need to run tubing in the well.

Automatic Soap Stick Launcher

Model-9P Launcher

Within the Launcher chamber, the carousel magazine holds 9 soapsticks.

There are 10 Launcher models for a variety of well conditions.


M-2
Midnight Launcher Series
with
'Select-n-Go'
Controls
Solar Electric and Actuated Ball Valve pre-wired
M-9EE
'Select-n-Go'
Controls
Solar Electric and ABV ready
M-9P
Pneumatic Series for Flowline Valve actuation including launch delay
M-18P
Pneumatic Series for Flow-Control Valve actuation including launch delay

Launchers for High Line PSI

M-9HL

- The Model 9HL is the preferred Launcher when the flowline pressure is between 350 PSI and 850 PSI.
- The lower chamber of the 9HL isolates excessive line pressure from the soapsticks that remain within the upper canister. (see Slide 27)
- The 9HL does not require flow line closure when the gas rate is less than 250-300 MCFD and the liquid rate is less than 25BLPD. (see Slide 13)
- The Model 9HL-EV can close/open an ABV in the flow line and will automatically delay the stick launch for 60 seconds when receiving a SCADA signal. (see Slides 15 and 21)
- The M-2 Midnight Launcher can operate at ≤850 psi differential and has a WP rating of 2000 psi.

SCADA Compatible

- All Launcher models are RTU - SCADA ready.
- Both Model P Launchers can control a gas-operated valve in the flowline with or without SCADA input.
- The solar powered Model EE and Midnight Launchers are capable of closing/opening a 12v ABV-CM in the flow line.
  (see prosealinc.com/actuated-ball-valve)
- When the RTU closes the flowline, it should also signal the Model EE processor which will automatically delay the stick launch by 60 seconds so that the flow from the well will not enter the canister. Excessive liquid encroachment into the Launcher is not a concern when using the Model 2 Midnight Launcher.
- The SCADA signal to all Launchers is a dry contact closure meaning there is no voltage-potential requirement.

Soaping Schedule

Chart Review

When should the next stick be launched?

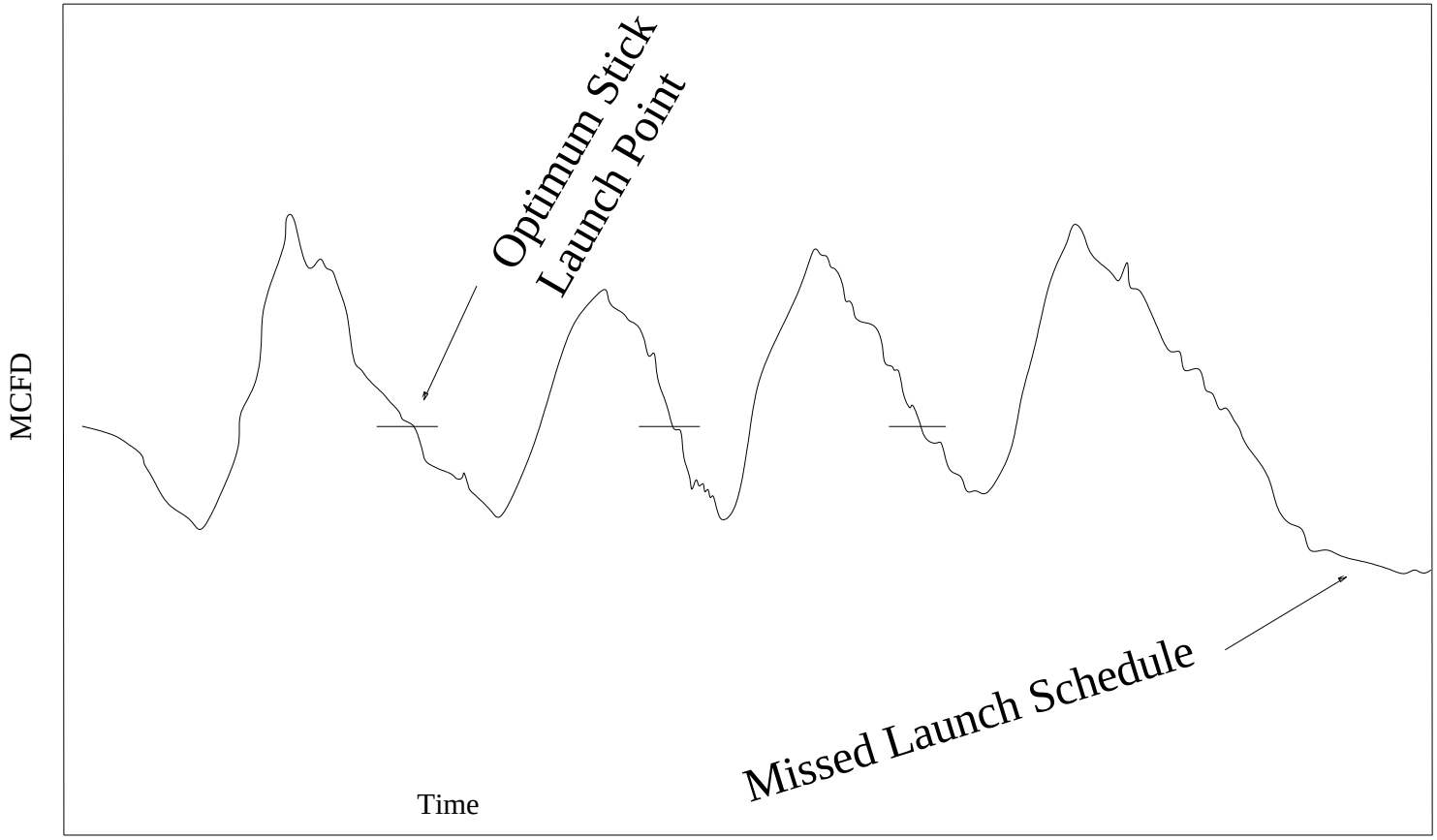


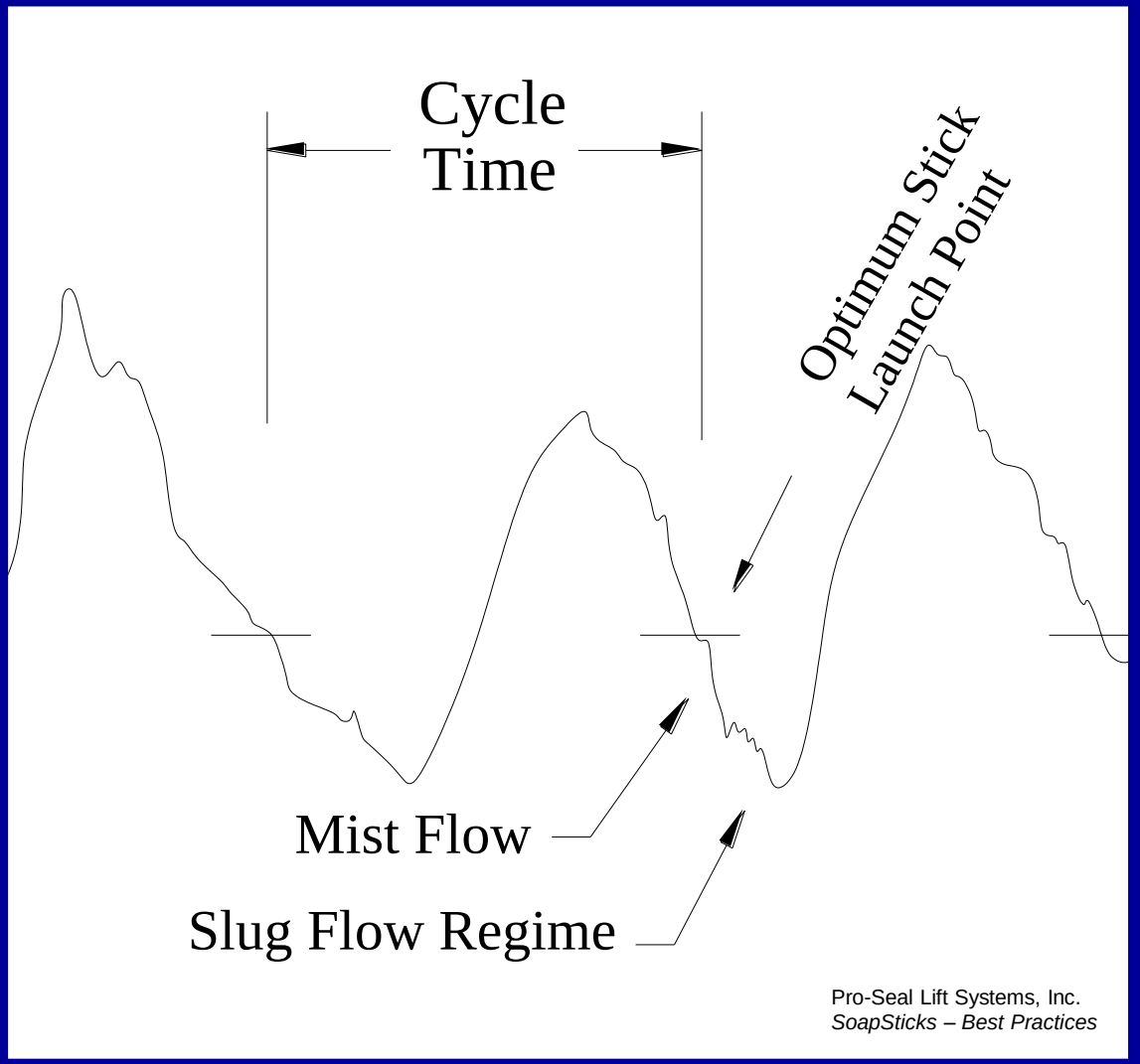
Figure 1 - Soaping Schedule, Continuous Flow in Vertical Well Bores

Soaping Schedule

Chart Review

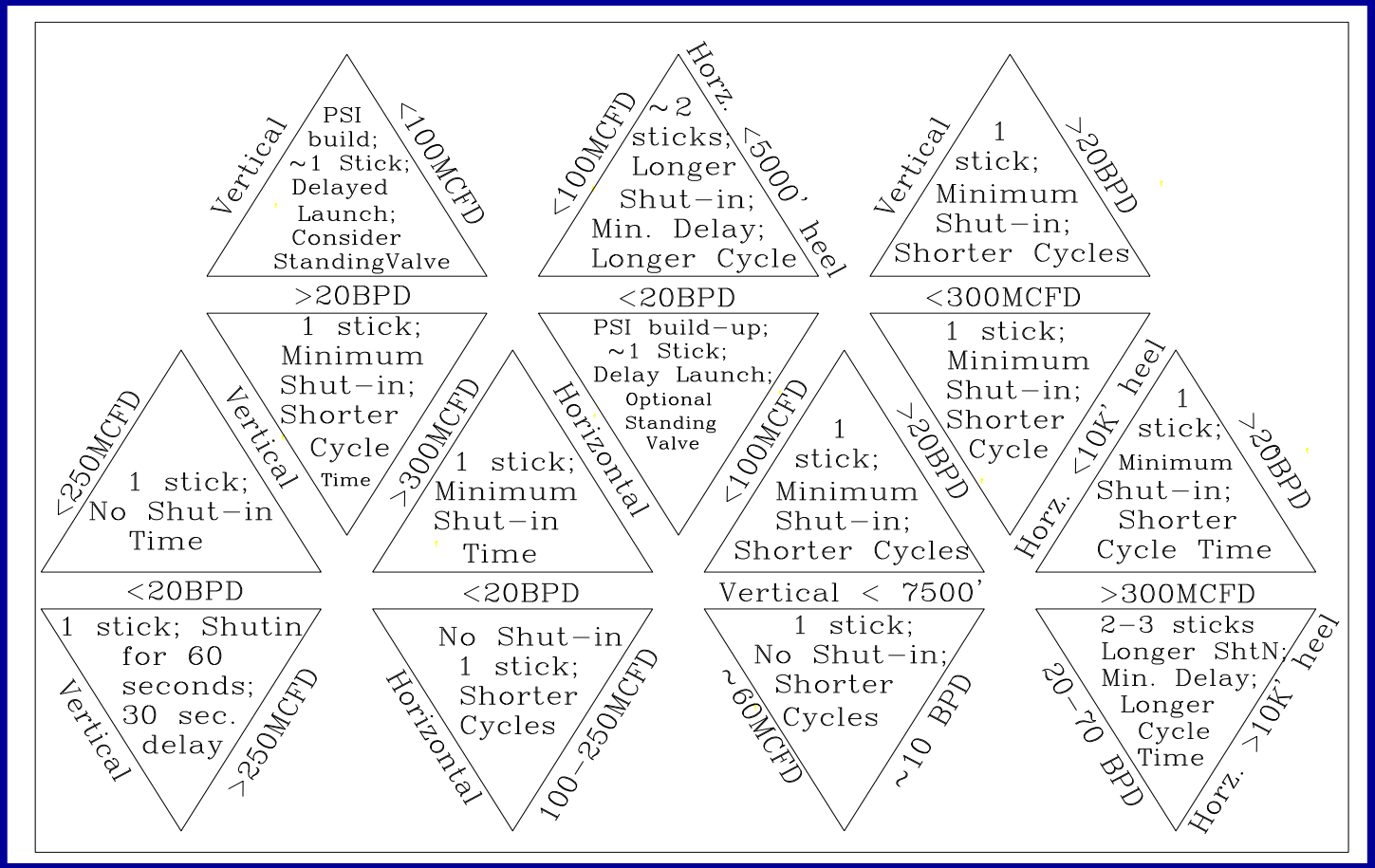
When should the next stick be launched?

- Note that the gas rate continues to decline as it struggles to lift the wet mist to the surface.
- After the mist-load crests the surface, it is followed by noisy water slugs untreated by surfactant.



(Vertical axis is exaggerated for effect)

'Rule of Thumb' Schedule



Identify the flow conditions outside the triangle and follow the recommendations within.

Review of the Soaping Practices

- Leave the well flowing (whenever possible)
- Shut-in the well if the flow rate warrants (slide 14)
- Drop just one stick at a time (but more frequently)
- Land the stick in the top of the water column
- Review the chart to determine the optimum soaping schedule (slide 22)

Limitations, part 1

Limitations for *Continuous* Use of Surfactants

- **High Condensate content (35% limitation)**
- **High Oil content (50% limitation)**
- **High Chloride content (add a *salt crystal modifier* stick)**

It is not harmful to occasionally drop one or more soapsticks into the production tubing of an oil maker. However, continuous use of former sticks in a majority-oil location can lead to the creation of an emulsion on the surface of the storage tank. Ask the vendor about a oil / condensate stick.

Limitations, part 2

Pressure Limitations for Soap Sticks

- **Soap Sticks are not damaged by a pressure increase;**
- **Soap Sticks <u>will shatter</u> during a de-pressurizing event;**

Pressurized gas enters the pores of a soapstick when the stick is within a pressurized chamber for an extended period. Whenever the chamber is de-pressurized, the trapped gas expands from within the soap stick causing the stick to crack apart. The maximum allowable pressure drop for a soapstick is 300-350 psi. The operator should launch any soapstick remaining within the canister prior to de-pressurization.
(review Slide 15 '*Duration of Shut-in*' and Slide 20, *Model-9HL*)

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