

SOLID EOR – FREQUENTLY ASKED QUESTIONS (FAQ's)

Question: If sticks work on gravity, how do they work in horizontal wells?

Answer for unloading jobs: You only need to unload the vertical part to get the well flowing again. You will unload the liquid column from the top, which reduces the hydrostatic pressure and allows more gas to flow from the bottom. The horizontal part will come out with the flow once the well is unloaded.

Answer for acid jobs: When dropping the stick it will start to dissolve going down the well. The dissolving time itself can be adjusted in three or four ways depending on the well, e.g. to adjust for temperature. Once the stick is dissolved the acid pellets that are inside are released and they will move down the well very slowly with gravity. The density of the stick is adjusted based on the angle of the well. 30 to 45 degree wells need less density to let the acid move down the well slower, and shut-in time is between 6 to 12 hours. From 75 to 90 degrees the job is more challenging as the acid pellets will move slowly. In this case the density of the acid pellets is increased to move the pellets down the well. Shut-in time is between 12-24 hours.

Question: What about wells with tubing obstructions or small valve openings. How do sticks pass such obstacles?

Answer for tubing retrieve valve: If sticks will pass depends on the on the valve size. The stick will pass if the ID is above 1.52 inch. If the ID is smaller the stick may not pass. To take away any doubts for unloading jobs there are also spherical soap balls that can be dropped in the wells. To take away any doubts on acid jobs, the acid product dissolved in fresh water and then pumped or poured into the well.

Answer for wire line retrieve valve: This valve can be taken out in case the valve ID is less than 1.52 inch. If the ID is larger the sticks will pass. To take away any doubts for unloading jobs there are also spherical soap balls that can be dropped in the wells. To take away any doubts on acid jobs, the acid product dissolved in fresh water and then pumped or poured into the well.

Question: After using the sticks, does it affect the quality of the oil or gas produced by the well?

Answer: The sticks only increase the volumetric production / injection, they do not change the chemical composition. The required quantity of sticks is calculated per well so that the chemical activity of the sticks is used up in the treatment of the well itself, so that after treatment there is no remaining activity. Moreover, as the sticks are designed per well to work at a specific target area, the quantity of applied chemical is minimal. Hence, sticks do not affect the quality of oil / gas / water after the treatment.

Question: What happens if there is no result (production of oil or gas doesn't go back to the previous or even improved volume), do we get back our money?

Answer: In case the technology does not work, it is normally because the problem with the well is something different than we are trying to solve. For example, if we aim to unplug a producing well by removing scale, but the actual cause of low production is a

mechanical plug in the well, the technology will not work. Hence, the input data is highly important in order to design the right solution. We do understand that we will initially be requested to prove the technology to new clients, and we are willing to offer trials on 'no cure no pay' basis.

Question: Is each individual stick tailor made, or is the treatment per well tailor made?

Answer: We use different types of sticks. Each type of stick has its own MSDS.

Question: Can gas / gas-condensate wells be unloaded directly to the downstream facilities?

Answer: Normally we unload wells to the local pit. The benefit of this operation is the minimum back pressure on the well and this is therefore the easiest way to unload the well. It is also the cheapest way as the minimum amount of sticks are required.

Another method is indeed to unload the well towards the facility. Also in this case we should try to minimize back pressure on the well by adjustments of operational conditions or e.g. by unloading to the test separator. Generally, it is important that the surface equipment is in good operating condition and that it can handle the fluid and pressure of the initial slug.

The amount of liquid to be received by the facilities depends on the tubing size and height of water column in the riser. The following numbers give an idea of the amount of liquid in the column. As you can see, normally it is only a small amount of liquid. It is just that the tubing has a small diameter that causes the hydrostatic pressure on the well.

1" EUE tubing = 1.1 BBLS/1000 ft.

2" (2 3/8) EUE tubing = 4 BBLS/1000 ft.

2 1/2" (2 7/8) EUE tubing = 6 BBLS/1000 ft.

3" EUE tubing = 9 BBLS/1000 ft.

3 1/2" EUE tubing = 12 BBLS/1000 ft.

Before we execute a job we calculate the amount of liquid in the column, so that we know how many sticks are required. Then, we continue to add soap sticks until enough of the liquid has been turned into foam for the well to unload itself. This operation ensures that we do not apply more soap sticks than required. As a result, all the foaming action is in the riser, and there will not be any foaming action in the facilities.

As the well is unloaded and the liquid column enters the flow line, it may cause slug flow. High liquid rates may fill up separators causing process trips due to high level. So before unloading the well to the facility, we check if the receiving separator has higher liquid capacity than the amount of liquid in the riser. Normally, the separator must already be sized based on the slug volumes expected from the wells so there should not be any issues.

In case the down-hole pressure is high enough for the gas expansion to accelerate the slug up the riser, it could cause excessive forces at pipe bends, particularly in low

pressure piping with thinner pipe wall. Normally, the piping must already be sized based on the slug forces expected from the wells so there should not be any issues.

Question: Do foaming chemicals affect the process downstream when unloading directly to the downstream facilities?

Answer: To produce the foam we need time, and a mix of the gas phase as well as the liquid phase of the well fluid to get a reaction going with the soap stick. Exactly these conditions are available in the riser. At the downstream facilities the liquid phase and gas phase are directly separated, so chemically there is no foaming reaction possible in the downstream facilities.

On top of that, there is only so much foam that can be produced per stick. The foaming takes place as the stick dissolves in the riser. We calculate beforehand how many sticks are needed. The sticks are added one every 5 minutes or so and we monitor the pressure increase at surface to know how close we are to unloading the well. With this method of operation we make sure we add the right number of sticks only. In other words, the foaming is over once the well is unloaded.

Question: Can sticks be dropped safely in highly sour wells?

Answer: Sticks are dropped through the lubricator, where the section between the valves is only 2 inch in diameter and 40 cm long. So this quantity of gas that needs to be bled off is not much. At least it is much smaller compared to other technologies.

However, may that still be a concern, we can use a tool for dropping with automated valves, so you can control the valve opening and closing from distance, so that you don't come near the sour gas. And there is of course the autoloader option which does.