MAXIMIZING PRODUCTION THROUGH IMPROVED DELIQUIFICATION IN HIGH OIL / WATER RATIO GAS WELLS

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ABSTRACT

Many gas wells produce water or a liquid hydrocarbon or a combination of the two. Often, the velocity of the produced gas is not sufficient to lift these liquids to surface and they accumulate downhole and decrease the well's gas production by applying pressure against the producing formation(s). One way to prevent this decrease in production is to apply a deliquification surfactant downhole. Very simply, these surfactants facilitate entrainment of the gas in the liquid phases, allowing the gas / fluid mixture to be lifted to surface with the existing velocity. Many surfactants work in water-only fluids or in hydrocarbon-only fluids, but most products fail to perform when the liquid hydrocarbons and water are near equal ratios. This paper will illustrate the laboratory work and successful field application of several specialty surfactants designed to handle a wide range of oil / water ratios, including equal mixtures of the two.

BACKGROUND

In the beginning of commercial oilfield production, often times, the sole goal of the production company was the crude production, with little regard given to the natural gas produced from the formation. As the value of natural gas has increased as a result of increased demand for energy sources, exploration for and removal of natural gas from reservoirs has come to the forefront of production enterprises. The result of this exploratory shift has led to the development of a new and better technology to facilitate the production of natural gas.

As natural gas wells mature, the reservoir production often shows an increase in the produced fluids relative to gas production. Produced fluids can vary widely from formation to formation and even within one particular field; however, they generally consist of a combination of produced water and condensate in some ratio. Condensate is the term often given to lighter weight crudes that often have a yellow to clear color depending on the gravity. When the velocity of the produced gas drops below the critical gas velocity, the well is no longer able to lift the produced fluids to surface.

To maximize the removal of natural gas, these produced fluids must be removed so that the natural gas does not have to fight the hydrostatic pressure being exerted by the wellbore liquids in order to come to surface. One of the best methods for the extraction of these fluids is with the use of a deliquification surfactant. Deliquification surfactants, commonly called foamers, facilitate the entrainment of the natural gas in the produced liquids. This action lowers the surface tension and the density of the produced fluids allowing them to be removed to surface with the natural gas. Removal of these fluids allows for an increased gas velocity and return to steady state flow.

One of the significant disadvantages of deliquification surfactants is their ability to work in the presence of condensate. Condensate will act as a defoamer in most situations. The presence of the condensate will disrupt the immiscibility of the water and gas the result of which is decreased foaming action, increased surface tension, and ultimately continued liquid loading. In situations where there is little condensate production, often the detrimental effects provided by the condensate can be overcome by increasing the amount of foamer added to the well. As condensate production increases as a percentage of total production, this becomes more and more difficult, the result of which is that chemical removal of produced fluids becomes uneconomical and mechanical process are often implemented.

DISCUSSION

In recent years, there have been several new advances with the development of new chemical technology designed specifically to combat the detrimental effects seen by condensate on deliquification surfactants. These deliquification surfactants can easily overcome 10-25% condensate of total production and have shown to be quite effective at ratios of 1:1 condensate to water and higher.

Foams produced by deliquification surfactants behave very similar to emulsions, the major difference being the dispersed phase. In a conventional water-in-oil emulsion, the water phase is dispersed throughout the oil. In a natural gas, produced water foam, the pas is the internal phase. A foam is produced by the introduction of natural gas into a liquid phase containing a surfactant. The lamellar film surrounding the gas contains surfactants with both hydrophobic and hydrophilic properties. In other words, one end of the surfactant molecule has an affinity for the hydrocarbon phase and the other end has an affinity for the aqueous phase. As the levels of condensate increase, the film surrounding the gas becomes less stable due to the increased levels of hydrophobic molecules. In order to overcome this, the deliquification surfactant must have more hydrophobic properties than has normal foamers.

Testing at the higher levels of condensate often becomes a difficult process. One of the most common techniques used for foamer testing is an industry standard blender test. Although there are varying setups, most tests involve operating the blender for a given amount of time (e.g. 20 sec) followed by evaluation of the foam height formed and the half life. The foam height is simply the total milliliters of foam formed during the testing process. Half-life is determined by the elapsed time necessary for one half of the treated water to fall out of the foam. The drawback to this testing procedure is that condensate proves so detrimental to the foam formed during the blender test that little (if any) foam is generated. Even if enough of the foaming agent is added to generate stable foam, the layers become much more emulsified and a true half-life is difficult to determine. Numerous tests have shown that with as little as 5 percent condensate added to the water, conventional blender tests become ineffective.

New testing procedures have been implemented in order to allow for testing increased levels of condensate during foamer evaluation. BJ Chemical Service utilizes a Foam Flow Column test. The Foam Flow Column test measures the amount (grams) of a produced water / condensate mixture that is lifted through a column by a known flow rate of an entrained gas (nitrogen) over a given test interval. Since the produced fluids are lifted using nitrogen, a slower mixing of the water and condensate occurs displaying the ability of the foamer to overcome the effects of the condensate. The Foam Flow Column is capable of testing water / condensate ratios of 1:1. The result of which is it allows for a more realistic simulation of what is occurring in the wellbore. Through extensive use of the Foam Flow Tower, products have been successfully developed in the lab and tested in the field in wells with high condensate / water ratios. Two such products are demonstrated in Figure 1. In this lab evaluation, two conventional deliquification surfactants with a strong track record in brine-only removal from gas wells in the Brighton- Colorado area failed to perform in new drills that were producing as high as 50% condensate. Two new chemistries were developed for this field that proved to perform significantly better than the earlier products.

In Indonesia, an Operator was having difficulty deliquifying gas wells containing high levels of condensate. The conventional chemistry used in the field for deliquification could handle up to 25% condensate (with increased dosing rates), but could not perform at levels above 25%. Testing shown in Figure 2 indicated that the conventional foamer could match the lifting ability of a newly developed condensate foamer – if the conventional foamer was used at 1.5 times the rate of the condensate foamer. However, increasing the rate of the condensate foamer to match the conventional foamer rate demonstrated the superior performance of the condensate foamer. To further illustrate the performance capability of the condensate foamer, the conventional foamer and condensate foamer were tested at comparable dosing rates in 50/50 mixtures of produced brine and condensate. These results are shown in Figure 3 and, again, reflect the improved performance of the new foamers developed for deliquification of gas wells containing significant levels of condensate production.

CONCLUSIONS

- Most conventional deliquification surfactants show limited performance in brine / crude mixtures where the amount of condensate is greater than 25%.

- There are new products available to aid in deliquifying wells with high condensate to brine ratios and these products indicate good performance for removal of condensate and brine in wells that have a 50/50 ratio of the two liquids..

- Test methods other than the Industry-standard Blender method are essential to the proper selection of deliquification surfactants when dealing with higher percentages of produced condensate or oil.

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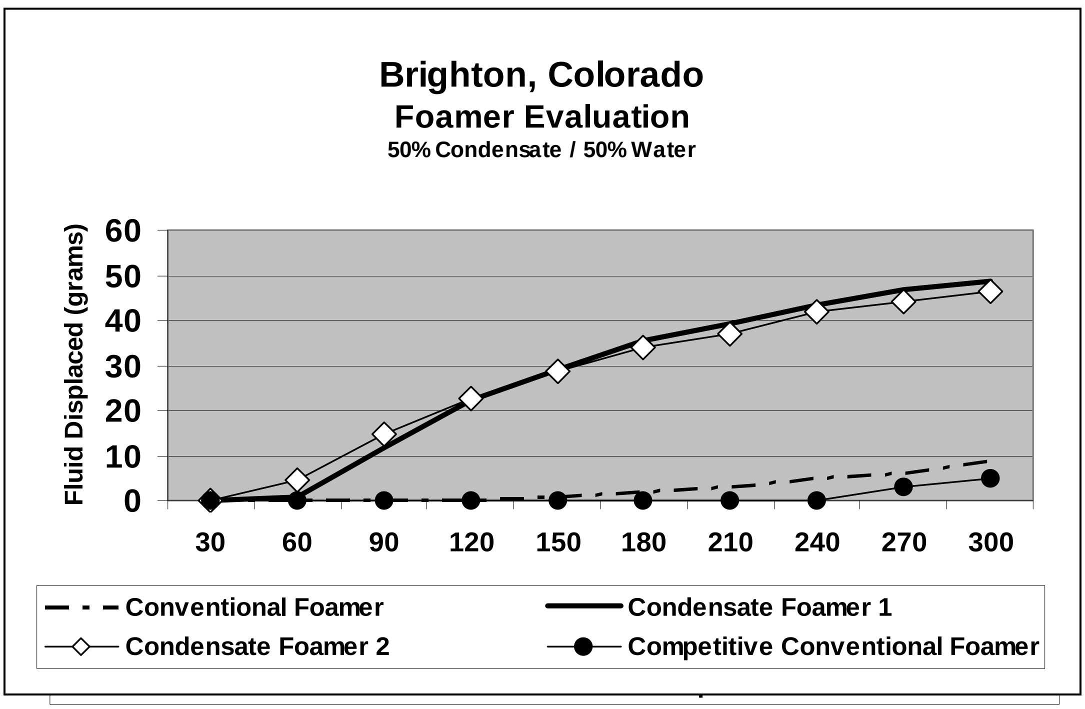

Figure 1

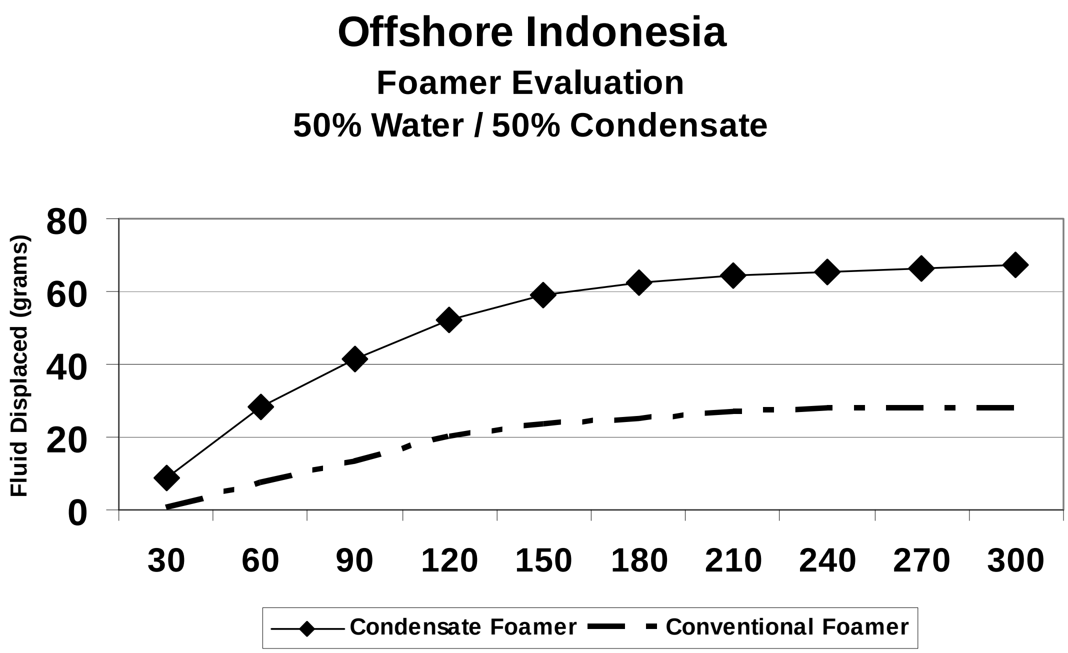

Figure 2

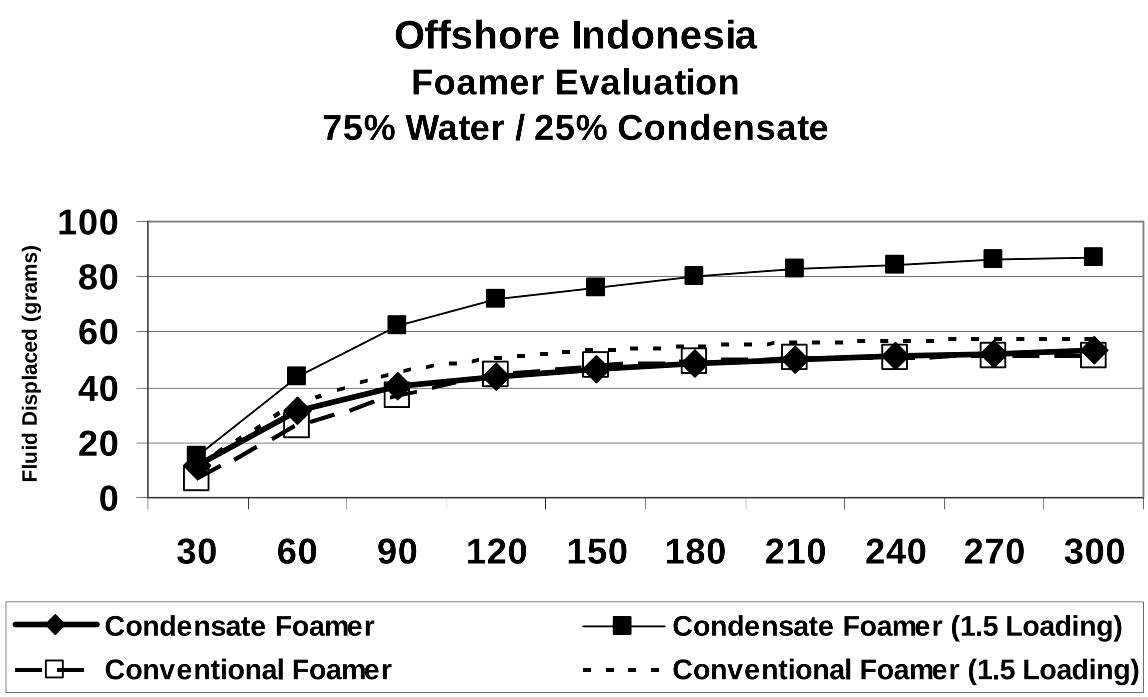

Figure 3