EFFECTIVENESS OF HIGH VISCOSITY FRICTION REDUCERS IN WELL COMPLETIONS

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ABSTRACT

Friction reducer is a hydraulic fracturing fluid additive meant to lower costs by decreasing the friction pressure in tubulars during pumping operations. High viscosity friction reducers (HVFRs) have become increasingly popular in well stimulation applications in lieu of conventional slick water fluid systems involving linear and cross-linked gels. However, various factors must be considered when assessing the effectiveness of using HVFRs under certain fracture operation conditions. This paper aims to evaluate how effective of a solution HVFRs are while determining the optimal operating conditions for this additive.

INTRODUCTION

High viscosity friction reducers have been increasingly popular in long lateral well completions involving larger proppant loadings. Some factors must be considered when evaluating the true effectiveness of these HVFRs. For the scope of this paper, I've chosen to measure effectiveness by studying proppant transport, fracture conductivity, on-the-fly design changes, and pumping rates. I've also inspected the difference in friction reduction created by HVFRs of particular viscosifying ratings. We must also consider the optimal conditions by inspecting brine composition and compatibility with certain chemical additives.

FACTORS AFFECTING HVFR PERFORMANCE

Brine Composition

When HVFR's were first used they were only rated to work at TDS levels of up to approximately 30,000 TDS. Once that threshold was surpassed, the HVFRs would no longer generate the expected results as they could no longer build viscosity. HVFRs used today are now more TDS-tolerant as we can use HVFRs that work with up to 250,000 TDS. All things considered, generally we can attain higher viscosities at lower TDS and higher loadings, i.e. increasing salinity yields lower viscosities[1]. In other cases where we have higher TDS, recent findings state that guar-based fluids are preferred under those conditions of increasing water salinity[3]. Furthermore, it's important to also note that some cationic HVFRs have provided quicker settlement rates than pure water while keeping greater initial fluid viscosities[1].

Chemical Additives

HVFRs are a good option when aiming for higher sand loadings for longer laterals. We would not use them when we don't have these high sand loadings or ramp ups and in vertical wells. However, one downside of using HVFRs is that we occasionally see wells that start producing back a lot of polymer approximately one month after being placed on production. This creates issues such as plugging up filters and surface facilities. This issue may be combatted by using the correct chemicals to break the polymers downhole. When using polyacrylamide we need to use delayed breakers so that we can break it down once its down in the formation. This way we can avoid formation damage and the loadings won't flow back in huge polymer slugs at the surface.

The use of HVFRs replaces our need for guar gels. However, we still need to use scale inhibitors, non-emulsifiers, flowback surfactants, breakers, etc. Therefore, we can also evaluate HVFR performance by inspecting their compatibility with other chemicals. It's important to also note that chemical loadings will also be affected. One common mistake seen in the industry is neglecting charge compatibility. For example, when using an anionic HVFR with a cationic biocide, then the anionic-cationic reaction will not fare well for our formation. Therefore, it is imperative when using anionic HVFRs to use anionic additives; similarly, we need to use cationic additives with cationic HVFRs.

IMPACT OF HVFRS

Proppant Transport

As our fracture package settles proppant into the fractures, large particles settle closer to the start of the fractures while top particles slowly travel further into the fractures[4]. This could be due to two reasons. First, the increased viscosity of HVFRs at lower shear rate causes the proppant to be suspended for a longer time as opposed to guar systems[4]. This may also be due to the fact that proppant suspension is enhanced by the HVFR's heightened elasticity in the high shear area which slows down the settling of the particles[4].

Fracture Conductivity

HVFRs are said to increase fracture conductivity as opposed to traditional low viscosity slick water fluid systems and linear and crosslinked gels[2]. One way we may test this is by running a "regain pore conductivity test" by flowing our fracture package through a core in lab. After flowing the package through that core, we must wait for some amount of time before flowing it backwards. Upon completion of this procedure, we measure the difference in pressure of both flow tests. By measuring the fluid retention as well, we can then figure out the extent of the damage done to our formation i.e. how much of the formation is plugged.

Design Changes

HVFRs are meant to be quick, on-the-fly additives of which loadings can be altered to suit different purposes. One benefit of this is that we can reduce loadings if our fracture job is going well in an attempt to reduce chemical volumes as well as overall costs[2]. Another benefit is that we can easily increase our HVFR-loadings thus increasing viscosity if we're attempting to go up on our proppant loadings[2]. Lastly, when dealing with fracture width restrictions we can increase our HVFR loadings to increase viscosity so that proppant can continue to flow past these points[2].

HVFRs may also be varied in their viscosity ratings to suit the desired treating pressure requirements. As can be seen in Figure 1, generally the higher the viscosity rating of the HVFR, the higher the friction reduction over the same set amount of time. However, while one may expect the highest rated HVFR to yield the highest friction reduction, that in practice is not true. In fact, FR-750 attains the largest friction reduction despite being less than FR-1000 in its viscosifying abilities. This may be due to the recent finding that too much viscosity may negatively impact our fracture package's ability to effectively suspend and transport proppant which, in turn, could lead to formation damage based on the type of polymer used[3].

Pumping Rates

Our main goal when hydraulically fracturing is to pump our fracture package at the highest rate attainable while staying below our maximum treating pressure. Using HVFRs allows you to lower your treating pressure so that you can increase your pumping rate. Thus, we have a smaller chance of screening out at those higher rates since our pressure will behave as it is expected to.

CONCLUSION

In essence, HVFRs reduce cost through the decreased chemical and equipment requirement and reduced need for water as opposed to traditional slick water systems[4]. Optimal conditions for HVFRs include lower TDS ranges & similar-charged chemicals. We see that the transportation of proppant deeper into our fractures is facilitated through the use of HVFRs. Therefore, fracture conductivity is also enhanced as opposed to slick water fluids. As quick, on-the-fly additives, these friction reducers can easily be manipulated to either lower costs and chemical loadings or to accommodate larger proppant loadings. In effect, using HVFRs could also help you increase your pumping rates while maintaining pressures below maximum treating pressures. It is essential to note, however, that HVFRs should mostly only be used for long lateral completions that require higher sand loading.

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TABLES AND FIGURES

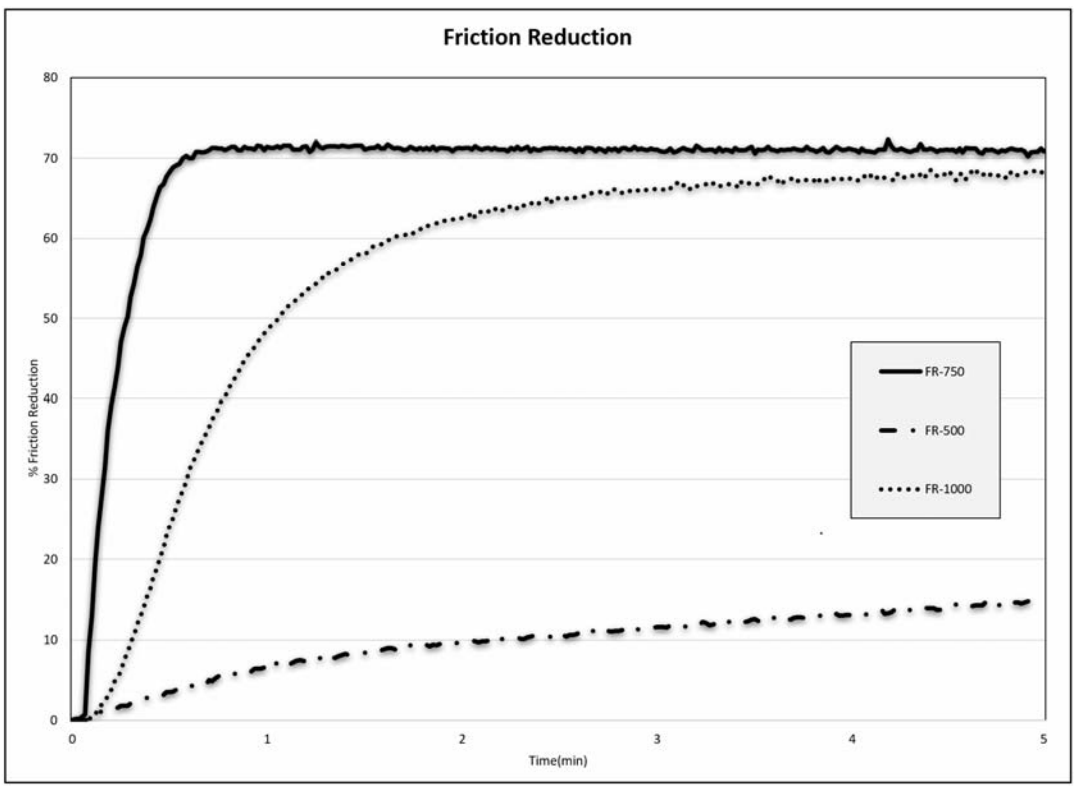

Figure 1 - Friction Reduction vs Time