The Effect of Various Additives on Matrix Acidizing Effectiveness in Carbonate Reservoirs

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SUMMARY

Matrix acidizing of carbonate reservoirs presents a challenge in the middle east as the horizontal legs become longer some now as long as 30,000 ft with some reservoirs at temperatures above 300 F. In this work we have investigated the diffusivity of acids and alternative acids with various additives vs temperature using a rotating disc apparatus. The pore volume to breakthrough (PVBT) was then measures on various carbonate cores such as Indiana Lime and cores form various Middle East formations. To show the impact of acid and additive selection we have built a horizontal wellbore simulator to predict the impact of lithology, acid type and various additives upon diffusivity and productivity.
Abstract

Matrix acidizing of carbonate reservoirs presents a challenge in the middle east as the horizontal legs become longer some now as long as 30,000 ft with some reservoirs at temperatures above 300 F. In this work we have investigated the diffusivity of acids and alternative acids with various additives vs temperature using a rotating disc apparatus. The pore volume to breakthrough (PVBT) was then measures on various carbonate cores such as Indiana Lime and cores form various Middle East formations. To show the impact of acid and additive selection we have built a horizontal wellbore simulator to predict the impact of lithology, acid type and various additives upon diffusivity and productivity.

One of the first observations is that corrosion inhibitors lower the diffusivity to values which are lower than previously reported. We have also measured the impact of various surfactants and nanoemulsion formulations on the diffusivity of 15% HCl and alternative acids.

The use of various additives including microemulsions in carbonate stimulation has the potential to significantly increase the efficiency of the stimulation treatment by optimizing wettability, retarding acid reactions, and enhancing fluid loss control. Coreflood experiments were also conducted using Indiana limestone cores (6 in. length and 1.5 in. diameter) and 1 in diameter by 4 in long formation cores form the Middle East to show the effect of additives on pore volumes to breakthrough and on wormhole morphology. The effect of injection rate was observed by conducting experiments at various flow rates from 1 to 20 mL/min., and the effect of initial permeability was observed by conducting experiments using cores with high (>140 md) and low (<10 md) initial permeabilities. CT scans were also done to show wormhole morphology. From this data a program was written to predict the diffusivity and optimum pumping rate. The addition of an optimized nanoemulsion to 15% HCl resulted in a diffusivity decrease of nearly 25%. This can be very beneficial when the injection rate is limited in coiled tubing operations.

A horizontal wellbore simulator was written to use the diffusivity and breakthrough results to estimate the production with and without the various additives. The model shows that optimizing the rate based on lithology and diffusivity can improve production by as much as 2 fold. Field examples are shown to demonstrate the technique.