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Field Test Measures Amount and Type of Iron in Spent Acids

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Abstract

The amount and type of dissolved iron present in spent acidizing fluids is important information for stimulation design. This information can be used to optimize the amount and type of iron control chemicals used in an acidizing treatment. With insufficient iron control, precipitation of iron-containing compounds can occur in the near wellbore area and reduce well injectivitity or productivity. Excessive amounts of iron control chemicals can add a significant unnecessary chemical cost to the treatment.

In the literature, the ratio of iron (II) to iron (III) from acidizing treatments ranges from 3:1 up to more than 25:1, with ratios of 3:1 most commonly reported. No details are available about the well type or the analytical methods used in the measurements. Typically only one data point was reported for each well tested.

In this work, a field method for iron (II) was selected and extensively tested for interferences present in live and spent acids. The method uses 1,10-phenanthroline to form a colored complex with iron (II) only. Total iron concentrations were measured in the lab by inductively coupled argon plasma emission spectroscopy (ICP). Iron (III) was calculated by difference.

Since iron (II) is readily oxidized to iron (III) in the presence of air, measurements of iron (II) were made in the field. Spent acidizing fluids obtained from seawater injection wells, oil production wells (dry wells), and oil production wells (high water cut) were evaluated in carbonate reservoirs in Saudi Arabia. At each well, samples were collected and analyzed over the entire flowback time of the treatment.

Results showed a variation in the iron (II)/iron (III) ratio and the total iron concentration depending on the well type. Oil production wells (both dry and wet) produced almost entirely iron (II), with low concentrations (less than 1000 mg/L) of total iron. Water injection wells had total iron concentrations up to 30,000 mg/L. In pickle treatments of seawater injection wells, iron (II) to iron (III) ratios from 0.7:1 to 2.0:1 were observed. In the main acid treatment after the well pickle, iron (II) to iron (III) ratios from 2.7:1 to 8.7:1 were measured. These results were calculated based on the amount of iron (II) and iron (III) produced over the entire flowback time of each well.

The results of the measurements were used to make significant cost reductions in similar acid treatments. In general, concentrations of iron control chemicals were much higher than required. Significant cost savings were made in the acid stimulation of seawater injection wells.

The following new results were obtained:

1. A field method was tested for interferences and adapted for measurement of iron (II) and iron (III) in acids and stimulation fluids.
2. Iron (III) was only observed in significant amounts in seawater injection wells.
3. The ratio of iron (II) to iron (III) observed in water injection wells was much lower (more Fe (III)) than previously reported.
4. Iron (III) reducing agents are not required in the oil production wells examined in this work.

Introduction

The amount and type of iron in spent acid has an effect on the cost of an acid treatment, the effectiveness of the treatment, and the potential of the treatment to cause formation damage.

From previous studies of iron contamination during acidizing, the largest source of dissolved iron comes from the reaction of the acid with corrosion products present on the casing[1-9]. This is the most significant route because the surface area of the casing is very large in comparison with the acid volume. Coulter and Gougler[6], and Gougler et al.[7] measured total iron concentrations as high as 100,000 ppm in returning acid from newly completed wells. They did not measure iron (II) or iron (III) concentrations or provide details of the measurement method.

Significant amounts of dissolved iron can also occur if the reservoir contains large amounts of iron-containing minerals[3,4], if corrosion of steel tubing occurs during the

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