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Cause analysis and scale control practice of water injection well in a Middle East Oilfield

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ABSTRACT

The waterflood development was adopted in a carbonate oilfield in the Middle East to enhance oil recovery. The injection water has high salinity and high Ca^{2+} concentration, which lead to scale deposition in the wellbore of water injection wells, even plugging the tubing and seriously impairing the normal water injection production. To explore the causes for scale deposition in water injection wells, X-ray diffraction (XRD) technology was used to analyze the composition of the scale formation on the tubing of water injection wells. The injection water scale tendency was simulated to find out the main scale components and the influencing factors with a scale prediction software. The scale deposited on the surface of the tubing was mainly FeS , CaCO_3 , FeOOH , and NaCl . Brine ratio, temperature, and ions concentration (Ca^{2+} , Fe^{2+} , etc.) have a significant effect on the scale tendency. High salinity, high Ca^{2+} concentration, the presence of Fe^{2+} , and highly corrosive produced water are the main causes for the scale deposition in water injection well. The scale and corrosion issues were well controlled by the method of adding scale inhibitor, corrosion inhibitor, and oxygen remover and adopting ultra-high molecular weight polyethylene (UHMWPE) lined tubing.

Key words: Scale deposition, Water injection well, Corrosion

INTRODUCTION

Scale deposition is one of the most common problems in the petroleum industry.¹⁻³ The scale problem can arise anywhere along water paths from surface equipment to the reservoir itself. The scale deposit can take place in the surface water injection facility, injection wells, formation, production wells, topside production facilities, pipelines, and disposal wells.^{4,5} It will cause severe injectivity/productivity problems. If no further timely action is taken, problems such as pipeline blockage, reservoir blockage, production decline, under-deposit corrosion, equipment damage, increased cost of pump inspection, and cleaning operation will threaten the long-term production and sustainable development of the oil field.⁶⁻¹⁰

Water injection is an important process to increase oil production and stabilize yields of oilfield.^{11,12} When water is being injected into the wellbore, its pressure and temperature will increase with the well depth. The changing pressure and temperature may cause the scale deposition on the tubing surface. Production water is commonly used as the injection water, but its salinity is usually high, which may cause scale deposition after injection. At the same time, some oxygen may be dissolved in the production water during the injection process, which may lead to oxygen corrosion in tubing and further aggravate the scaling issues.

In this paper, the scale deposition issue for the water injection wells in a Middle East oilfield was discussed. The scale deposition mechanism was analyzed in combination with the scale deposition simulation calculation, and the key factors affecting the scale deposition. Finally, the method of controlling the scale deposition was given, and has been applied in the oilfield with positive results obtained. This paper can provide a useful reference for the scale control of the water injection wells.

RESULTS AND DISCUSSION

Scaling status

To build up formation pressure and enhance oil recovery, a carbonate oilfield in the Middle East adopted waterflood development. In recent years, 102 wells have been inspected and 56 perforations have been investigated among 130 water injection wells in this oilfield in the Middle East. It was found that there were serious scaling issues in the tubing of failed wells. Figure 1 shows the scale and corrosion morphology of tubing with scaling issues. The scale layer is thicker, which leads to the serious shrinkage of the tubing. It is worth noting that some of the scale products are distributed in a nodular form, and the bottom of the nodular scale has obvious local corrosion. The average corrosion rate can reach 3.6mm/a, and the risk of under-deposit corrosion is relatively high.

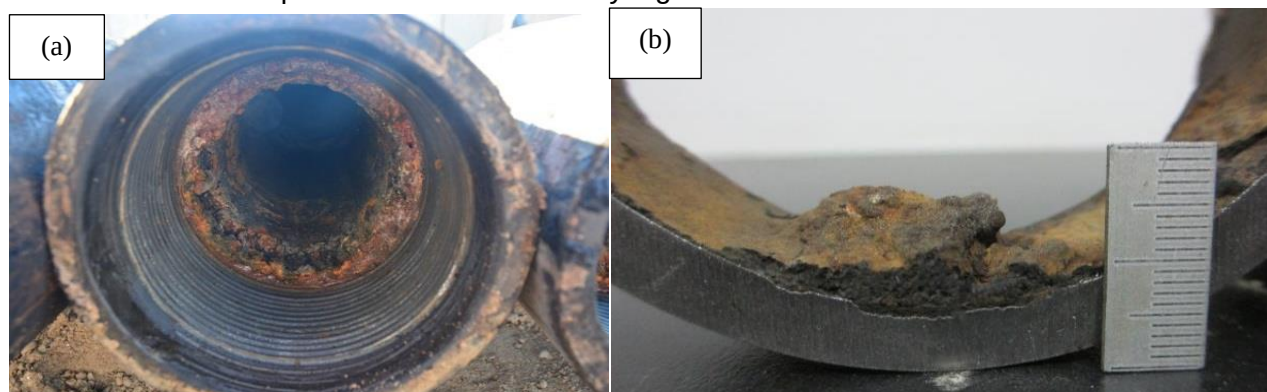


Figure 1: Scale and corrosion morphology of tubing with scaling issue

The number of pipelines with scaling issues at different depths was investigated. As shown in Figure 2, the scale deposited at all the depth of the wells. There was few tubing with scaling issues at the wellhead and the bottom, and scale deposition was more common in the middle of the wells. At the same time, the number of perforations in the tubing at different depths was counted. As shown in Figure 3, the number of perforations in the tubing is most in the middle of the well. This result is consistent with the statistics of the tubing with scale issues in Figure 2, indicating that there may be a certain relationship between perforation and scaling.

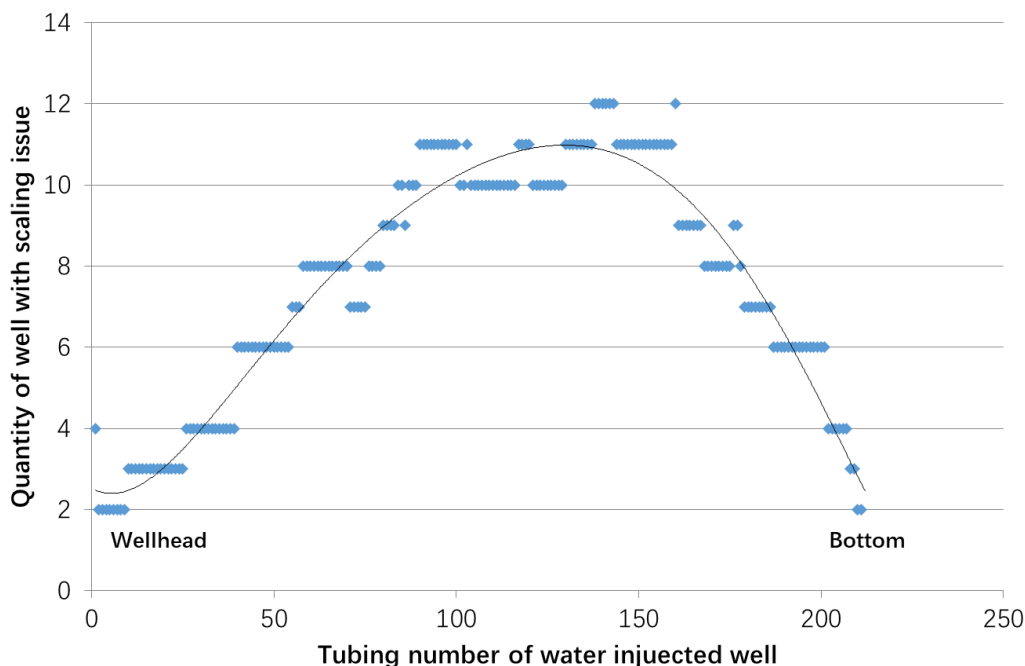


Figure 2: Quantity of well with scaling issue in different depth along the tubing string

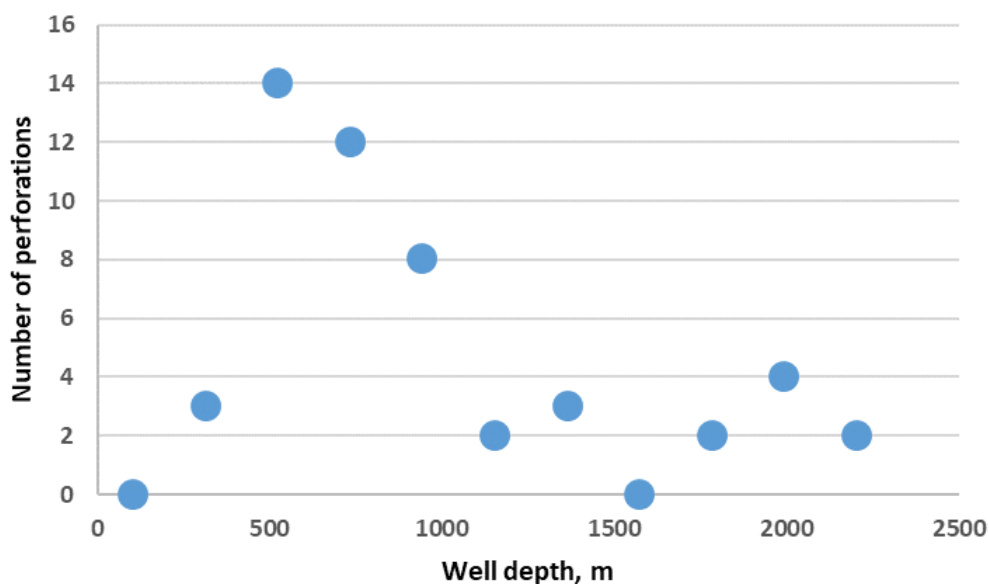


Figure 3: The number of perforations in the tubing at different depths