The application of using EDTA to dissolve calcium sulphate deposits for plugged ESP wells in Rumaila oilfield

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Abstract. In Rumaila oilfield, many electric submersible pumps (ESP) have been found plugged during commissioning shortly after the new pumps were installed. After these failed plugged pumps have been replaced through workover rigs, the new pumps still face the same problem. Based on the result of root cause failure analysis, this paper describes the potential root cause of pump failure, the solution to treat the plugged pump, the operation steps and application effects of using ethylenediaminetetraacetate acid (EDTA) to dissolve calcium sulphate (CaSO4) deposits for plugged ESP wells in Rumaila oilfield, providing references for solution of similar issue and application of this technology.

1. Introduction

The Rumaila oilfield is a super-giant oilfield located in southern Iraq [1,2]. The Main Pay reservoir is the main oil interval in Rumaila. Since the reservoir pressure dropped due to depleted development in Main Pay reservoir in south Rumaila, more and more natural flow wells have ceased in the last couple of years. In order to make these ceased wells back on-line, the electric submersible pumps (ESP) were installed in these ceased wells.

However, many electric submersible pumps (ESP) have been found plugged during commissioning shortly after the new pumps were installed. In addition, after these failed plugged pumps have been replaced through workover rigs, the new pumps still face the same problem and are easy to be plugged during commissioning or shortly afterward.

To solve this problem, the failed pumps have been pulled out of from well borehole through workover rigs and were sent to lab for root cause failure analysis. Based on the result of root cause failure analysis, this paper describes the potential root cause of pump failure, the solution to treat the plugged pump, the operation steps and application effects of using ethylenediaminetetraacetate acid (EDTA) to dissolve calcium sulphate (CaSO4) deposits for plugged ESP wells in Rumaila oilfield, providing references for solution of similar issue and application of this technology.

2. Root cause failure analysis

Figure 1 shows that severe deposit is observed from internal part of failed plugged ESP which was pull out of from well borehole during commissioning. Figure 2 shows that the deposit looks like flaky crystal under the view of scanning electron microscope.
Future investigation through spectrograph shows the rate of element Ca to element S is 1 which indicates calcium sulphate (CaSO₄) is the main component of the deposit which is also verified in many sample analysis results acquired from different plugged pumps (Figure 3).

3. Solution

The deposit samples acquired from different failed pumps were sent to lab for sample analysis which also indicated the sample is identified as calcium sulphate. Further extensive lab testing identified EDTA as the best product to dissolve the deposit.

Ethylenediaminetetraacetate acid (EDTA), also known by several other names, is a chemical used for both industrial and medical purposes [3]. It was synthetized for the first time in 1935 by Ferdinand Münz [4]. It is an aminopolycarboxylic acid and a colourless water-soluble solid which is widely used to dissolve lime scale. The EDTA is a versatile chelating agent, which can form four or six bonds with a metal ion, and it forms chelates with both transition-metal ions and main-group ions [5].

Based on the lab sample test result, it is decided to pump EDTA to Ru-XXX well which has a plugged pump and try to use EDTA to dissolve calcium sulphate deposits which might be potentially plugging the ESP internals, and then attempt to start the ESP and make this well back on-line.

4. Operation procedure

Ru-XXX is a producer in Main Pay reservoir in south Rumaila oilfield. This well was completed through installing an ESP in 2017 with an initial oil rate of 2 Mbd. However, during the new ESP
commissioning, the pump was plugged. Therefore, it is decided to try to pump EDTA to dissolve the plugging deposits and release the plugged pump. The operation procedure is showed in Figure 4.

**Mobilize all equipment required to well site.**

**Pump 17.3 bbls of 1.15 sg brine as spacer, followed by 6 bbls of mixed solvent and 80.2 bbls of 1.01 sg brine down the tubing.**

**Returns to be taken up annulus via choke manifold to flare pit.**

**Line up tubing head via choke manifold to flare pit.**

**Wait 24 hrs for soaking time and equalization across ESP.**

**Stop pumping after 6 bbls of mixed solvent and 80.2 bbls of 1.01 sg brine have been pumped.**

**Attempt to start ESP and flow back the mixed solvent from tubing through choke manifold to flare pit.**

**Monitor returns and ensure all spent mixed solvent is recovered.**

**Divert the well to degassing station and rig down all equipment.**

**Figure 4. Operation flow chart**

Mobilize all equipment required to well site. Prepare 6 bbls of mixed solvent as per the recipe showed in Table 1 for flushing ESP. With keeping the annulus open, pump 17.3 bbls of 1.15 sg brine as spacer, followed by 6 bbls of mixed solvent and 80.2 bbls of 1.01 sg brine down the tubing to cover the internals of pump. Returns to be taken up annulus via choke manifold to flare pit. Stop pumping after 6 bbls of mixed solvent and 80.2 bbls of 1.01 sg brine have been pumped and wait 24 hrs for soaking time and equalization across ESP.

**Table 1. Mixed solvent recipe**

| Solvent       | Volume       | 6 bbls in total (252 gal) |
|---------------|--------------|---------------------------|
| # Description | Concentration| Quantity                  |
| 1 Fresh Water | 490 gpt      | 123.6 gal                 |
| 2 Corrosion Inhibitor | 10 gpt  | 2.4 gal                  |
| 3 Formic Acid | 50 gpt       | 12.8 gal                  |
| 4 EDTA        | 450 gpt      | 113.6 gal                 |

Line up tubing head via choke manifold to flare pit. Attempt to start ESP and flow back the mixed solvent from tubing through choke manifold to flare pit. When the ESP starts successfully with formation fluids being observed at surface, monitor returns to make sure all spent mixed solvent has been recovered and then divert the well to degassing station and rig down all equipment.

5. **Effect evaluation and discussion**

The operation duration for Ru-XXX is one day. Before the operation, this well was shut-in with a plugged ESP. After the operation, the pump was successfully released and the well was back on-line with an oil rate of 2 Mbd. With the successful experience obtained from Ru-XXX, many other plugged
ESP wells were also treated using the same operation procedure with a quite high successful rate. The successful plugging deposit dissolution operation shows that using EDTA to dissolve calcium sulphate deposits for plugged ESP wells is a quick and cost-effective way to make the plugged ESP well back on-line in Rumaila oilfield.

Through the lab test, it is clear that it is the calcium sulphate deposits that has caused the ESP plugged. There are two main source of calcium sulphate in the well borehole. One source is from the workover fluid (brine) during the workover operation when the new pump was installed which has been verified through brine sample lab test. However, when the high sulphate brine has been replaced with low sulphate brine, the new ESP still experiences frequent plugged. The second main source of calcium sulphate is from formation fluid which is the mixture of natural formation water and injected water from nearby injectors. Obviously, the main source of calcium sulphate is from formation fluid because the ESP still experiences frequent plugging after the high sulphate brine was replaced.

The reason of deposits formation is still unclear. However, the potential reason is that because of the high sulphate formation fluid, when the ESP is running, the motor temperature is much higher than the temperature in well borehole, and the high temperature and high pressure near the ESP may cause the calcium sulphate begin to accumulate in the ESP intake which will eventually plug the ESP. It is also observed that the ESP installed in low oil rate well is much easier to be plugged than the ESP installed in high oil rate well. This can be explained by the reason that there is lower fluid velocity going through the ESP in a lower oil rate well borehole in which the high temperature ESP motor can make the well borehole fluid temperature higher than that in high oil rate well borehole and cause the calcium sulphate begin to accumulate.

6. Conclusions
The successful plugging deposit dissolution operation shows that using EDTA to dissolve calcium sulphate deposits for plugged ESP wells is a quick and cost-effective way to make the plugged ESP well back on-line in Rumaila oilfield.

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