Proceedings World Geothermal Congress 2010
Bali, Indonesia, 25-29 April 2010

The Acidification Process Of Producing Wells In Kizildere Geothermal Area And Effects On Well Performance

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Keywords: Acidification, Well testing

ABSTRACT

At the Kizildere Geothermal field, 25 deep wells and 108 gradient wells have been drilled as of January 2009. Ten are production wells, one is an injection well and three are the observation wells. Production decreases over time as a result of scaling since there is no inhibition system used in the field. When electricity generation of the power plant decreases to 10 MW, production is recovered by conducting mechanical cleaning in the wells. In 2008, an inhibiton system was installed for the wells KD–14 and KD–20 and currently operates successfully. The inhibition system is planned to be installed for all the wells in the field in 2009. The production wells whose productivity indexes appeared to decrease according to tests were acidized to increase production. Acidizing operation were performed twice. In 2008 and 2009, 40 tons of HCl and 600 kg of corrosion inhibitor were used for each well and 360 tons of HCl and 5400 kg corrosion inhibitor, respectively. The acidizing operations, their advantages and disadvantages, and the effects on the productions are evaluated in this paper.

1. INTRODUCTION

The Kizildere (Fig.1) Geothermal power plant started operation in 1984 with a capacity of 20.4 MW_e and currently has a capacity of 9-11 MW_e. After calcite scale cleaning the production capacity was increased to 15 MW_e. However, the production decreased to below 10 MW_e with time. To increase the production again, mechanical cleaning was necessary to clean up the calcite.

In the field, the KD-6, KD-13, KD-14, KD-15, KD-20, KD-21, KD-22 production wells and the R-2 injection well were tested before and after the acid injection and after mechanical cleaning (Fig.2).

Before acid injection, multirate injection and fall-off tests were conducted in the well in which calcite cleaning was performed. After acid injection, the well was produced for 3-4 hours to clean up. Then, a James Tube (lip pressure) production test was conducted. Finally, another multirate and fall-off test was performed and the well was put into production.

In the field, 19 wells were drilled at a depth of below 1000 m, three wells were drilled at a depth between 1000-1500 m and three of them were drilled between 2000-2300 m (Fig.3).

2. ACID INJECTION INTO THE WELLS

Mechanical cleaning was performed in the wells. Cold water was injected into the wells and drill pipes of 3 ½" were lowered into the wells to the depth of the reservoir. The system was tested and the pressures were observed via pumping 10 m^3 of water to the system after the connections of the acid tank, pump and the well were done (Fig.4).

10 m^3 capacity polythene acid tanks used in the field were filled. 400-500 lt of water and 150 kg of corrosion inhibitor were added to each tank and a mixture has formed with 30% HCl. During that time, water was pumped into the well with a rate of 10 lt/s with another pump. After four tanks were filled with the acid, the water injection pump was started and acid was pumped into the well. Initially, the rate was low, but later, the injection rate increased to 10-13 lt/s. After the acid injection, acid in the pipe was purged with water. Water injection continued until the string was pulled out of the hole.

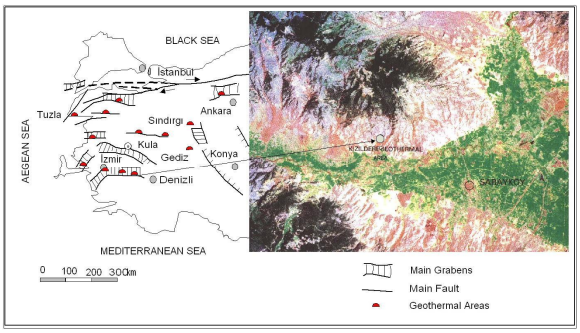

Figure 1: Kizildere geothermal field

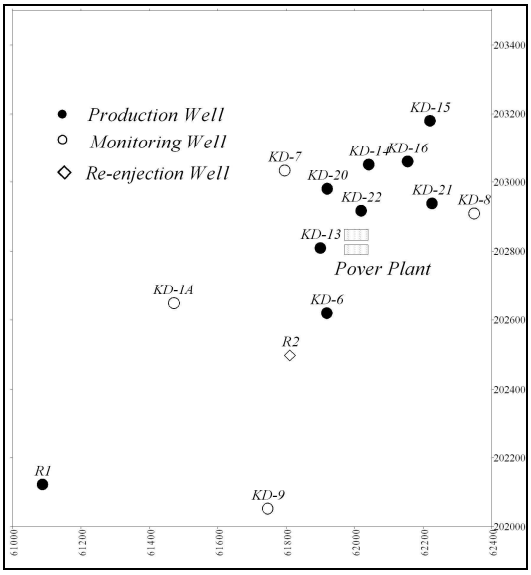

Figure 2: The well location of Kizildere geothermal field (Dunya 2008)

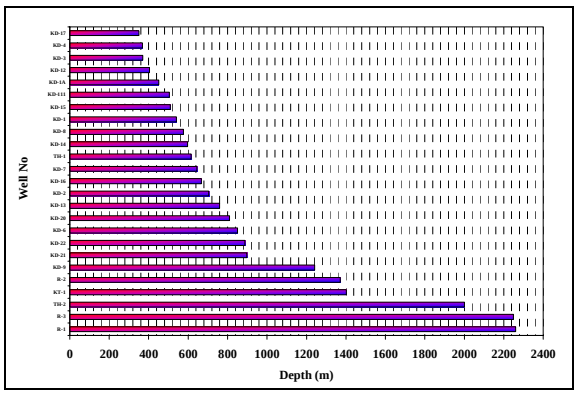

Figure 3: The wells at Kizildere Geothermal Field and their depths

In these operations, one engineer, one primary driller, one driller, one mechanic and six drilling workers were involved. Special safety equipment was used by each employee during the operations.

. ACID INJECTION INTO THE KD–22 WELL

In order to put across cutting scaling materials in the well, the drilling series were down onto. During production period the materials thrown out with high pump flow rate. Furthermore, 3 ½'' DP were stated at 613 m, secondly BOP (Blow Out Preventer) and RCHP (Rotating Head Control Preventer) were closed on 25.12.2008.

600 kg of Rodina 50 corrosion inhibitor were used to prepare 39,220 kg (34.05 m^3) approximately 30% HCl at well-site on 26.12.2008. Before acidizing operation, 10 m3 water was injected to the well by a cementing unit pump for cooling down the well bore in order to increase corrosion inhibitor lifetime. Then acid mixture was injected into the wellbore with 10 lt/sec flow rate over 46 minutes. Displacement of the acidizing was performed with 66 m3 fresh water during 110 minutes.

After pulling out the drill string, full open flow cleaning was performed and gas separation was evident during this flow period. This clean period was continued over two hours until the clean vapor and liquid flow.

3. THE DETERMINATION OF WELL PERFORMANCE AFTER ACIDIZING

3.1. Comparison of James Tube (lip pressure) Production Before and After Acidizing

James Tube (lip pressure) of KD-13, KD-14 and KD-15 production wells and production performance after 2007 mechanical reaming operations are shown below.

3.1.1 KD-13 Well

When production data for KD-13 well are compared between the mechanical reaming operations in 2007 and 2008, James Tube (lip pressure) values are in the 6 and 11 bar range with increasing 40 t/h production rate after acidizing operation in 2008. This data is illustrated in Figure 5.

In recent years, PI(Productivity Index) value was calculated to be 616 (t/h)/bar when there are not scaling problems. After the acidizing operation in 2008, PI was calculated to be 675 (t/h)/bar.

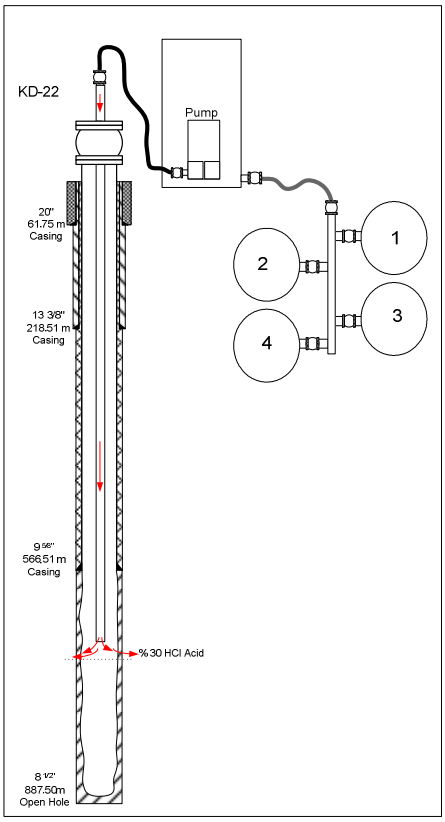

Figure 4: The acidizing schematic of KD-22 Well

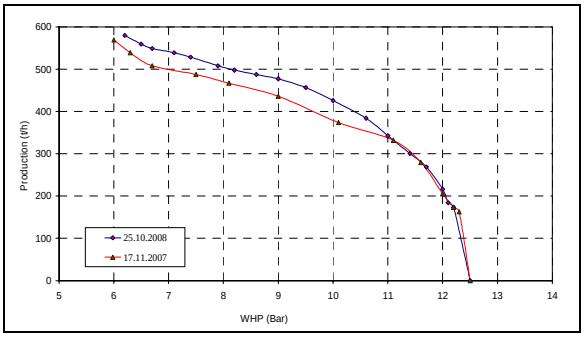

Figure 5: Relative James Tube (lip pressure) Production of KD-13

3.1.2 KD-14 Well

When production data for KD-13 well is compared between the mechanical reaming operations in 2007 and 2008, James Tube (lip pressure) values were in the 8 and 13 bar range with increasing 39 t/h production rate after acidizing operation in 2008. This data is illustrated in Figure 6.

Furthermore, PI value was calculated as 117 (t/h)/bar without any scaling problem in recent years. After the acidizing operation in 2008, PI was calculated as 193 (t/h)/bar value.

3.1.3 KD-15 Well

When production data for KD-15 well is compared between the mechanical reaming operations in 2007 and 2008, James Tube (lip pressure) values were in the 8 and 13 bar range with increasing 90 t/h production rate after acidizing operation in 2008. This data is illustrated in Figure 7.

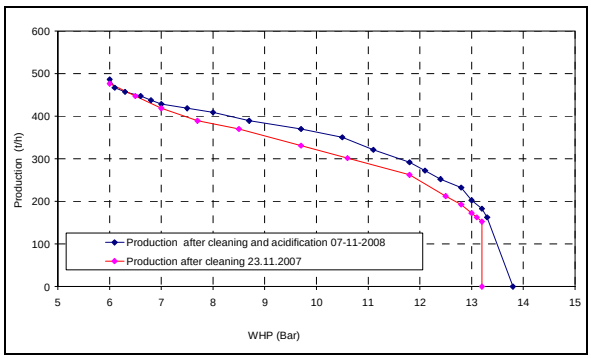

Figure 6: Relative James Tube (lip pressure) Production of KD-14

Furthermore, PI value was calculated to be 266 (t/h)/bar without any scaling problem in recent years. After the acidizing operation in 2008, PI was calculated as 317 (t/h)/bar value.

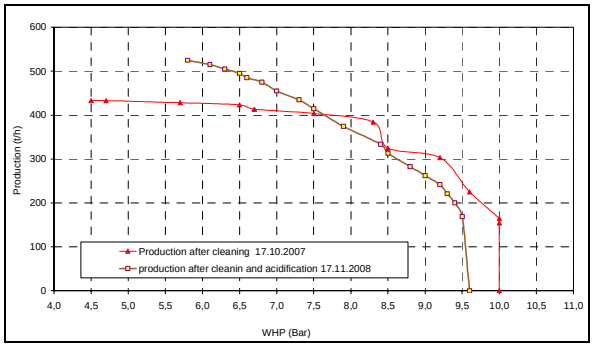

Figure 7: Relative James Tube (lip pressure) Production of KD-15

3.1.4 R-2 Well

Before acidizing, flow rate was 132t/h and temperature was 130°C. Injectivity index was approximately I=20(t/h)bar during constant flow rate injection testing.

Multi flow rate injection well testing was performed after approximately 80 tons acid was injected. During the well testing with the brine coming from KD-20, KD-14 and KD-16 wells, the temperature was approximately 130°C. As a result of well testing injectivity index was calculated to be I= 128(t/h)bar (Fig. 8).

It is indisputable how much a difference acid injection made on the well performance.

While 2.2 bar WHP and Q=107t/h injection was made at R-2 well before acidizing, then 2.1 bar WHP and 325t/h flow rate injection was carried out. The well capacity has increased by three times.

3.2. Well Production before and after Scale Cleaning

After calcite cleaning, well scaling occurred during production. Therefore, the production of wells was reduced. Mechanical cleaning helped recover the original production well rate.

3.2.1. The Variation of Well Production Before and After Well Cleaning

With scaling, production was reduced even at low WHP pressure. After cleaning with high WHP pressures, higher flow rates were obtained. Most of the time, flow rate more than doubled. This process is occurs periodically each year (Fig. 9).

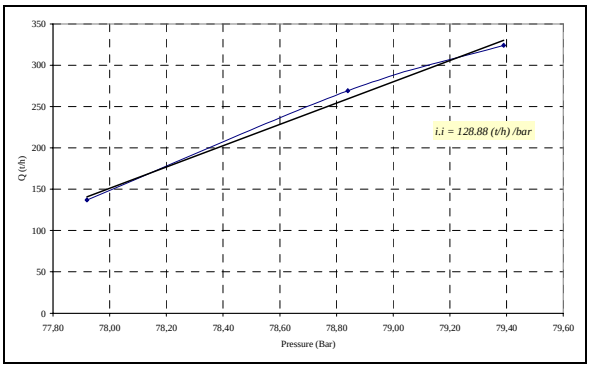

Figure 8: R-2 Injectivity Index

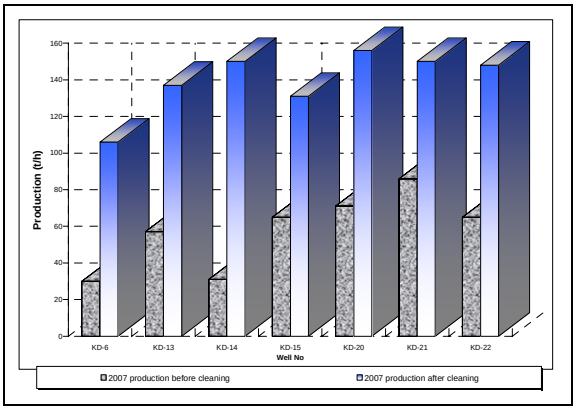

Figure 9: The variations of wells before and after Cleaning

3.2.2. Variation of Production before and after Cleaning

Producing values of the last two years are compared for the wells injected with acid after mechanical. Here, with the effect of acidizing, observable increases at productions were achieved. At 2006 and 2007 after cleaning slight increases in the production performance were observed (Fig. 10,11,12).

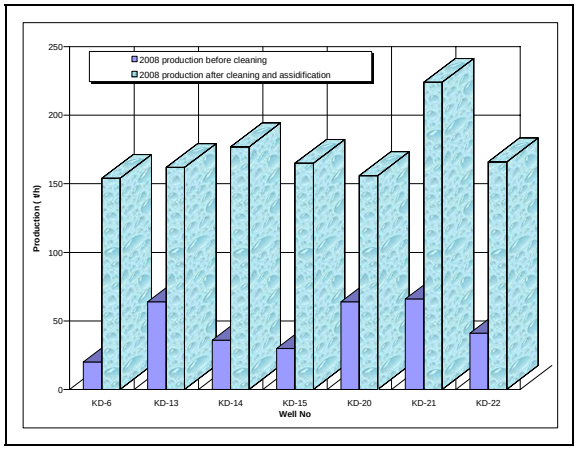

Figure 10: 2008 The production variations of wells before and after Cleaning-Acidizing

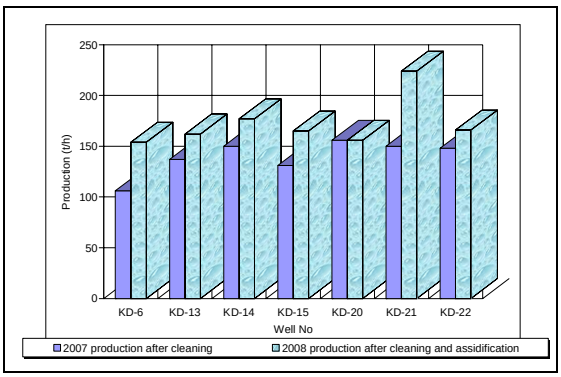

Figure 11: The wells Production at 2007 After Cleaning and 2008 After Cleaning-Acidizing the variation of wells Before and after Cleaning

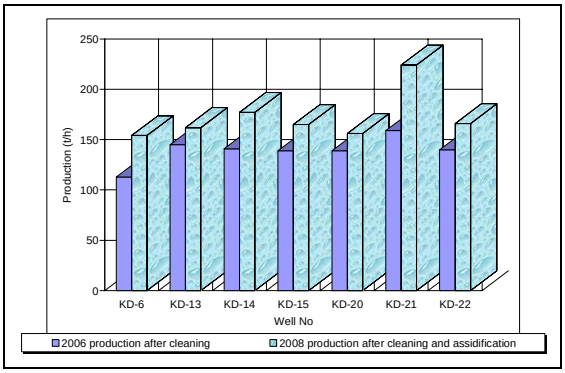

Figure 12: The wells Productions at 2006 After Cleaning and 2008 After Cleaning-Acidizing

4. RESULTS

Acidizing was performed on seven different production wells of Kizildere Geothermal field in order to clean the wells. The re-injection well R-2 was acidified at two different depths.

After acidizing an increase of 30-40 t/h in the flow rate of the production wells was observed. Productivity indices were also quite good.

In the re-injection well, the results were quite satisfactory. The R2 well accepted 3 times more waste water at lower pressure WHP.

After acidizing, gas release of strong odor took place during initial production of the well. This was undesirable because it resulted in environmental pollution.

Overall, a successful acidification gave positive results.

The use of a higher flow rate pump may improve flow rates further.

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