

Restoring Geothermal Injection Well Capacity Using an On-line Chemical Cleaning Approach

BACKGROUND

Proper maintenance and operation of geothermal wells and surface equipment is vitally important in achieving any geothermal plants operational objectives whether it is for power production or district heating. The harsh operational conditions found within a geothermal plant; high temperatures, brine solubility, and non-condensable gasses, can cause deposition and/or corrosion concerns throughout the entire plant; production wells, surface equipment, and injection wells.

If the brine solubility limits are exceeded anywhere within the process, mineral deposits can begin to form creating process flow restrictions which can lead to curtailed production, increased parasitic power demand to overcome increased operational pressures and lost profits.

Common approaches to remove the flow restricting mineral deposits and



restore plant capacity include; high pressure hydro blasting, alkaline/ acid washing and well work-over (for the production or injection wells). Within geothermal systems, most deposition concerns are found within the surface equipment and injection wells, although the production wells, depending on the brine composition, are also prone to fouling with calcium carbonate and calcium sulfate. Injection wells generally experience concerns with silica based mineral scale deposition and some of the sulfides of antimony, arsenic, lead, copper and iron.

ENVIRONMENTAL IMPACT

Allowing for the replenishment of geothermal natural resource

eROISM

ECONOMIC RESULTS



\$1,200/day



1MW/day

eROI is our exponential value: the combined outcomes of improved performance, operational efficiency and sustainable impact delivered through our services and programs.

SITUATION

A geothermal plant was experiencing reduced electrical generation capacity caused by flow restrictions in their injection well. The injection well flow rates had decreased by 22% to 0.78 million lbs./ hour and the overall injectivity KPI for the well had decreased by 75%. The injectivity KPI is a ratio of the mass flow/ operating pressure required to produce the flow. The flow restriction within the injection well caused the plant to throttle back the production well flow rates resulting in a loss of steam production and corresponding MGW turbine output. In addition, the injection well pump pressure had increased by 45% to 112 psi, thus increasing the parasitic electrical load on the plant. Overall, the facility had been losing ~\$1,200/day (~1MGW/ Hr @\$50/MGW) in lost revenue opportunity under their current operating conditions.

The plant had previously tried to restore the injection well capacity by performing an off-line chemical cleaning using a hydrochloric / hydrofluoric acid blend (HCl/HF) to remove the restrictive deposits. This cleaning approach was ineffective at restoring the desired brine flow capacity and the plant began investigating the use of more aggressive cleaning options.

SOLUTION

Understanding the plant's desire to restore their operational capacity, Nalco Water provided a recommendation for an alternate strategy to remove the restrictive injection well deposits and eliminate the flow restriction.

To avoid the risk of marginal or hit or miss type cleaning performance, Nalco Water developed an approach to remove the guesswork in selecting



Program added at the well head of the injection well.

the appropriate chemical-cleaning agents required for optimal cleaning performance. This approach identifies the best chemical cleaning profile while taking into consideration the programs application for ease of handle, environmental impact, and aggressiveness toward process equipment and well casing.

The following approach was utilized in the selection of the optimal chemical-cleaning agents.

1. Deposit samples were collected from the injection well.
2. A complete analysis of the deposit was performed to determine its primary composition.

Note: If a deposit sample is not available, Nalco Water's GEOMIZER modeling tool can be used to predict the deposit composition by using the brine chemistry, NCG (non-condensable gas), steam chemistry and well characteristic including temperature, enthalpy or pressure to identify probable deposit composition.

3. Based on the composition of the deposit and using Nalco Water's extensive laboratory and the field experience data banks, the optimal chemical-cleaning agents were selected for this job.

Note: If a deposit sample is available, the estimated chemical cleaning effectiveness can be verified by performing dissolution studies on the sample.

The deposit analysis from the injection well showed 83% Silica, 7% black iron silicate, 6% calcium sulfate and 2% aluminum. Using the laboratory and field data bank, Nalco Water's GEO991 advanced cleaning agent was identified and a dissolution study was performed to confirm program selection. Given the characteristics of the GEO991 program which is safer to handle and less aggressive to system equipment and well casing materials when compared to a HF/HCl based chemical cleaning, an on-line cleaning methodology was developed that allows for the program to be introduced at the well head limiting well downtime. The customer accepted this approach and proceeded with implementing the chemical cleaning. Based on the amount of deposit present, it was determined that the chemical cleaning would be conducted over the course of a 48-hour period. During this time, the program dosage was adjusted to target a pH of 4.5 - 5.0 in the brine entering the injection

well. The normal pH of the brine being reinjected was 5.5. During the time of the on-line cleaning, the well pressure and flow rates were monitored.

After the 48-hour online cleaning was completed, the injection well injectivity KPI improved by 73%. The mass flow rate increased from 0.78 million lbs /hour to 0.94 million lbs. /hour. A 20% improvement in flow. In addition, the injection well pump pressure decreased from 112 PSI to 78 psi. A 43% improvement that amounted to a decrease in the parasitic power load by 0.5 MW.

In total, the plant improved their overall TCO by gaining an additional 1.0 MW (0.5 from Parasitic and 0.5 from plant) of sellable power while eliminating costly plant downtime by taking advantage of Nalco Water's GEO991 on-line chemical cleaning approach.

CONCLUSION

Nalco Water has developed an on-line chemical cleaning approach which avoids production interruption while effectively removing scale and deposits within the geothermal process, increasing process flow rates and increasing plant output and profits. This approach is also less aggressive when compared to conventional acids to process equipment.

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