New Silica Inhibitor Allows Geothermal Power Plant to Increase Generating Output

NALCO Water
An Ecolab Company

CASE STUDY - POWER
CH-1329

Since it is considered a renewable and green energy source, geothermal power is one of the fastest growing segments in the industry with generating capacity projected to increase >10% annually for the foreseeable future. These plants use geothermal energy from hot brine brought to the surface via deep wells (6,000 – 10,000 ft) where its enthalpy is released, through flash tanks and/or heat exchangers creating steam and/or vaporized isopentane to drive turbine-generators. The cooled brine is then pumped back into the earth through injection wells to replenish the geologic formation.

PROBLEM

Brine typically has very high levels of dissolved minerals, up to 30% in some cases, which can be concentrated to even higher levels as steam is removed in flash plants. One such mineral, silica, causes one of the industry's biggest operating problems through the formation of scale and deposits that plug heat exchangers, piping and well internals. Since silica solubility decreases with decreasing temperatures, the threat of silica scale increases as the geothermal processes remove heat from the brine. At plants where silica in the brine is high, the plant usually designs and

Customer Impact	eROI[SM]	Economic Results
Additional MW Generation output	ENERGY	>$525,000/yr
Cost avoidance of cleaning heat exchangers.	COSTS	One cleaning per year, savings: $175,000/yr
Cost avoidance of few "acid jobs" to chemically clean injection wells.	COSTS	One acid job per year, savings: $100,000/yr
Improved System Reliability for maintaining >80% capacity factor.	RELIABILITY	Reduced risk of being designated as "degraded resource" leads to $1,000,000 bonus.

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

installs a process to either remove silica via a crystal reactor clarifier (CRC) or increase its solubility by dropping pH by adding acid (known as "pH mod"). Both of these options are extremely expensive to implement and maintain.

For many years, water treatment companies have been searching for an effective silica inhibitor that would help prevent deposits at a cost-effective dosage. To date these efforts have fallen short of the industry's expectations.

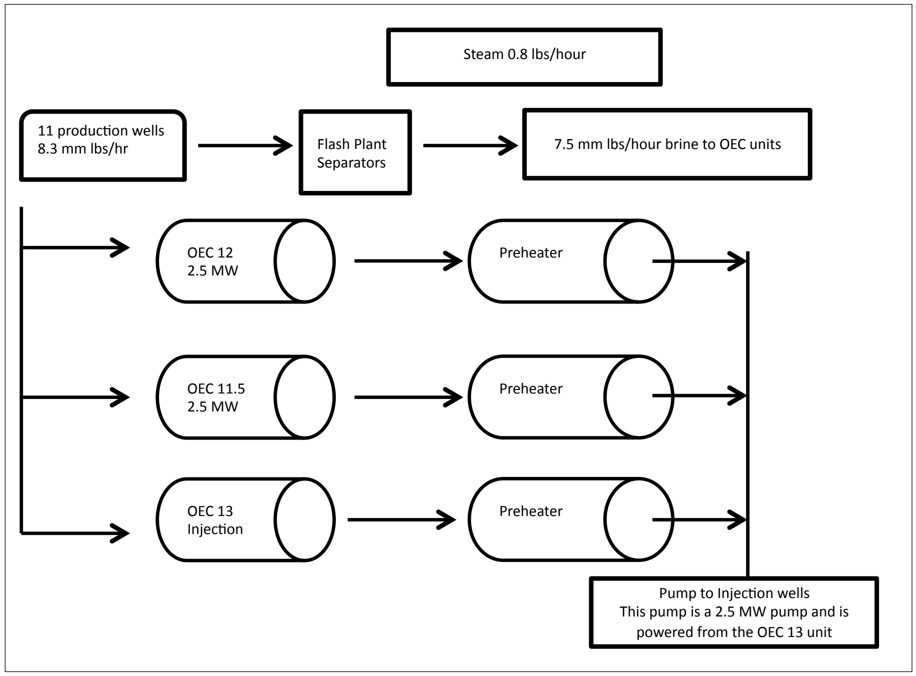

Figure 1

SOLUTION

Nalco Water's research and development group has been searching for a silica inhibitor that can withstand the high temperatures and pressures of the geothermal brine process and yet be cost-effective for commercial use. After significant laboratory testing, Nalco Water developed a new proprietary silica inhibitor which showed to be far more effective than existing inhibitors on the market.

One of the largest geothermal operators in the world was struggling with silica deposits fouling their binary Ormat Energy Converter (OEC) units at a combined flash and binary plant. This problem caused decreased electrical output, higher maintenance costs and risks associated with acid cleaning of the equipment. Silica, unlike other minerals, becomes less soluble at lower temperatures. The silica deposits, both amorphous and iron silicates, formed in the headers and heat exchanger tubes of their three OEC units and further downstream in the injection wells. This required multiple mechanical and chemical cleanings of the OEC units and acid cleanings of the injections wells since these machines were installed in 2006.

In an effort to minimize these silica deposit problems, Nalco Water's field engineers worked with the client to initiate silica inhibitor feed to their brine flow upstream of the three OEC units. The trial of the silica inhibitor was initiated in the fall, following a mechanical cleaning of the OEC heat exchanger tubes. The units were significantly fouled with silica-based deposits and were only restored to about 30-40% of original heat exchange efficiency.

In an effort to regain more of the lost thermal efficiency of the OEC units, a chemical cleaning was initiated the following spring, where efficiency was increased to about 55-60% of original design.

MONITORING

During the trial period, the effectiveness of the silica inhibitor treatment was tracked by monitoring the thermal efficiency of the OEC units and deposit build-up on several retractable scale coupons inserted into the process flow. Thermal efficiency was measured by the mega-watt (MW) output of each OEC machine. Scale build-up on the coupons was measured weekly using a caliper to record the thickness of the coupon. The official goal of the trial was to keep deposit formation on the coupons to $<$ 1.2 mm/yr.

The initial feed rate of the silica inhibitor was started to maintain a dosage of 2 ppm fed to the inlet brine header of the OEC units based on a total flow of 7.5 million lbs/hr. The third OEC unit, which only sees about 13% of this total flow, experiences a much lower outlet temperature of 130°F, and subsequently higher scaling rates compared to 160°F for the other units. Thus, a secondary feed point was installed at this unit to add another 2 ppm of the silica inhibitor to ensure silica scale control on this lower temperature unit.
Figure 1 shows a simplified flow diagram of the OEC units.

As the weekly coupon inspections and MW generation data suggested no additional formation of scale, the dosage was reduced to 1.2 ppm. At this level, silica deposits started to show up on the coupons, so the feed-rate was increased back to 2 ppm and left there for the remainder of the trial.

The photos below (Figure 2) show the scale coupons pulled near the end of the trial and show zero scale build-up.

Figure 2

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