CASE STUDY

Third-Generation Silica Inhibitor Program Helps Geothermal Power Plant to Extract 5% More Energy

BACKGROUND

Geothermal power generation has received a lot of attention due to its accelerating growth. Countries that are rich in geothermal resources can grow their geothermal power production and reduce dependency on fossil-based energy sources that contribute harmful greenhouse gas (CO2) emissions to the environment.
In past years, geothermal energy utilization has been limited to high enthalpy reservoirs, but as the demand for renewable energy increases, geothermal power generation companies have begun exploring lower enthalpy reservoirs. Binary systems are the main tool for energy extraction in these medium to low enthalpy reservoirs, and adoption of this technology is expected to increase exponentially in the coming decades. The major roadblock in these systems is the risk of prograde solubility mineral scale deposition, which are silica and silicates. If left uncontrolled, the plant reliability will be diminished, electricity production will be reduced, and the affordability of the geothermal plant will be questioned.

Conventionally, to safely extract the energy from these resources, binary power plants are designed and operated by limiting the outlet temperature to keep the Silica Saturation Index (SSI) 1.0 – 2.0. The lower outlet temperature will help mitigate the risk of silica and silicate scaling formation, but it also forces the plant to miss out on potential additional production.

SITUATION

A geothermal power plant in Indonesia faced the issue of silica and silicate scaling at their plant in a medium enthalpy reservoir. Their goal was to extract as much energy as possible through the binary power plant, with outlet temperature as low as 700C or with SSI as high as 2.95.

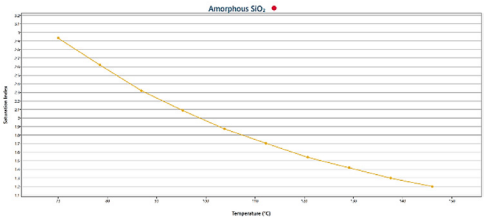

Figure 1

Nalco Water's geothermal experts used our proprietary Geomizer™ modeling tool to simulate the scaling and corrosion risks.

ANNUAL SAVINGS

PRODUCTIVITY

Improved by 5%

$201,600

COSTS

Reduced maintenance

$300,000

TOTAL VALUE DELIVERED

$501,600

They found that, in addition to the silica and silicate scaling, there was a risk of aluminum silicate because the brine contained 1.1 ppm of aluminum. If this scale were to form, the cleanings would require significant plant downtime, labor, and cost. Knowing this, it was decided that the power producer's goal would be to increase MW production and decrease the number of binary system cleanings per year. However, as conventional silica and silicate scale control programs began to fail over an SSI of 2.0, an innovative program would be needed to achieve these goals at an SSI of 2.95 or even past 3.0.

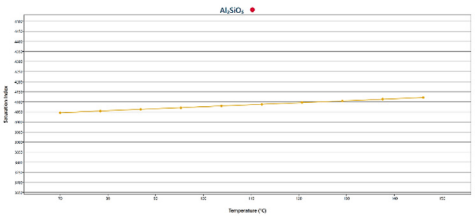

Figure 2

NALCO Water
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eROI℠ by Ecolab

SOLUTION

Nalco Water has developed a new generation of silica inhibitors that could meet these needs, helping to break the conventional SSI limit. After a site feasibility review, it was determined that the new technology could be a potential fit for this application.

The plant began by implementing Nalco Water's Silica Inhibitor Program 2.0. This program allowed the plant to begin controlling the scale past the usual SSI limit, into the range of 2.0-2.5 as is sufficient for most binary plants. However, the power producer desired to push the limits further, so this became the benchmark we aimed to improve upon.

The breakthrough came with Nalco Water's Silica Inhibitor Program 3.0. This proprietary inhibitor program was tested in a two-month trial against a wide range of available options, including the already best-in-class 2.0 Program, with the goal still to reach an SSI of 2.95 or 3.0.

RESULTS

In this high SSI system, the new silica and silicate inhibitor program 3.0 has shown significantly improved inhibition compared to the silica inhibitor program 2.0 that was designed for systems at SSI 2.0-2.5. The performance comparison between these programs can be seen in the table below.

CONCLUSION

Nalco Water's Silica Inhibitor Program 3.0 proved that it will help geothermal operators effectively manage their binary power plants past an SSI of 3.0, as the name suggests, achieving all goals set out in the trial. In fact, it was shown that it will be effective at least until the SSI reaches 3.5, almost double from the conventional working SSI. With this development, it is expected that the geothermal power plant can safely and efficiently exploit medium to low enthalpy reservoirs.

With the Silica Inhibitor Program 3.0, the plant electricity generation is maintained stable, the run length is maintained longer, and the cleaning frequency is reduced.

	2.0 Program	3.0 Program
Average % Polymerization	6.4%	4.9%
Average % Al Retention	66.4%	79.52%
Scaling Rate	0.3 mm/year	0.12 mm/year
Cleaning Frequency	2-3 months	6-8 months

		2.0 Program	3.0 Program
Cleaning Frequency	/year	5	2
Downtime for Cleaning	hours/year	840	336
Production Loss	$/year	336,000	134,400
Cleaning Cost	$/year	500,000	200,000
Cleaning Cost	$/year		501,600

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