Steam Purity Challenges in Geothermal Power Plants:

A case study of Olkaria IAU power plant.

Nkapiani Melissa / November 1, 2018 / Kigali Convention center, Rwanda.
Olkaria field is one of the geothermal prospect in the Kenyan rift system.

Field is divided into 7 production sectors.

Four conventional plants and wellhead units.

Generates ~ 533Mw
Introduction

• Olkaria geothermal power plants are single flash condensing type with evaporative cooling towers.

• Power plant chemistry therefore becomes vital.

• Steam quality checks/monitoring
  • Condensate chemistry
  • Drain ports cleaning mechanism
Steam quality monitoring

• Steam purity is an important aspect for flash plants as the geothermal steam interacts with the steam turbine directly.

• Geothermal power plants design recommends steam purity of 99.90%

• Contaminants in steam: Cl, SiO2, Na, H2S, CO2
  • Brine carryover
  • Volatility of chemical components
  • Inefficient cleaning mechanism
Steam quality chemical monitoring parameters

- Steam quality monitoring is done continuously for all the power plants. The parameters monitored include conductivity, total dissolved solids, pH, chloride and silica.

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Standard steam inlet purity recommendation (mg/kg)</th>
<th>Standard steam inlet purity limit requirement (mg/kg)</th>
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</thead>
<tbody>
<tr>
<td>Na</td>
<td>&lt;0.1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Cl</td>
<td>&lt;0.1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>SiO2</td>
<td>&lt;0.1</td>
<td>&lt;1</td>
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(Source: Power Engineers, 2014)
Condensate chemical monitoring

- The steam inlet to Unit IV turbine does not meet the recommended industrial standard of steam purity.

- Cl< 1mg/kg and SiO2 <5mg/kg

- Plant operators also observed increased water level at Unit V scrubber
The steam inlet to Unit V turbine does not meet the recommended industrial standard of steam purity.

- $\text{Cl} < 1\text{mg/kg}$ and $\text{SiO}_2 < 5\text{mg/kg}$.
Steam lines delivering steam from the separator stations have drain ports along the line to get rid of steam condensate that forms along the steam line.

The sets of drain ports near the separator station are the first line of defense against water carry over, such that at the drains ports near the power plant, only steam condensate with no dissolved components is obtained.

Samples from 7 separator stations were collected and analysed for pH, Conductivity, TDS, Na, Cl and SiO2.
The location of the separator stations is such that it can serve groups of wells that are close to each other.

Cyclone separator stations OW 35, OW 718, OW 32, SE1, SE2, SE3 and SN3
Condensate drainport chemistry

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**SE1 Chloride and Sodium concentration**

<table>
<thead>
<tr>
<th>Drain ports</th>
<th>Conc (mg/kg)</th>
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<tbody>
<tr>
<td>A</td>
<td></td>
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<td>B</td>
<td></td>
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<td>C</td>
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<td>J</td>
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Condensate drainport chemistry

SE2 Chloride and Sodium concentration

Drain ports

Conc (mg/kg)
Condensate drainport chemistry

SE3 Chloride and Sodium concentration

Conc (mg/kg)

A1  A2  B1  B2  C  D  E  F

Drain ports
Olkaria IAU drainport chemistry

• From the chemical analysis, Separator stations SE1 and SE3 steam pipeline network reported high concentrations of dissolved chemical components.

• The chloride and sodium concentrations along SE1 and SE3 steam line do not show a general decline.

• These separator stations have the last drain ports recording concentration of > 4 mg/kg chloride and > 5 mg/kg Silica against recommended standard limit of ≥ 1 mg/kg chloride. Indicative of carry-over of separated water to the steam line.
Isolate and assess the separation effectiveness, SE3 and SE1 separator stations.
Upon inspection of the SE1 and SE2 separator stations, debris was found to have clogged the brine line, preventing separated water to flow to reinjection well.
WHP of OW 13 reinjection well indicated a pressure build up resulting to a kick back of separated brine back to the separator unit and then to the steam line.
OW 13 was then shut and separated brine from SE1 and SE3 separator stations redirected to OW 17.
Maintenance process routine process- monitor pressure build up
Conclusion

• Continuous steam quality monitoring for steam quality check.

• Condensate drainport chemistry is therefore vital in steamfield management

• Reinjection wells wellhead pressure monitoring should be done regularly to monitor pressure build up.
Thank you

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