ETHIOPIAN ELECTRIC POWER CORPORATION

EFECT OF SOLID DEPOSITION ON GEOTHERMAL UTILIZATION AND METHODOS OF CONTROL

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Common Solid Depositions encountered in geothermal fields

- Calcite (Calcium carbonate)
- Silica deposition
- Sulphide
- Sulphur

Background on Solid depositions

- Isotopic evidence tells us that geothermal waters are largely meteoric in origin.
- Meteoric water seeps into the ground and reacts with the host rock and alters the characteristics of the geothermal water since rock minerals are dissolved into it.
- The heated geothermal fluid is rich in dissolved minerals & ascends and while passing through rocks and fractures cools and initiate boiling due to loss of hydrostatic head.

Cont'd

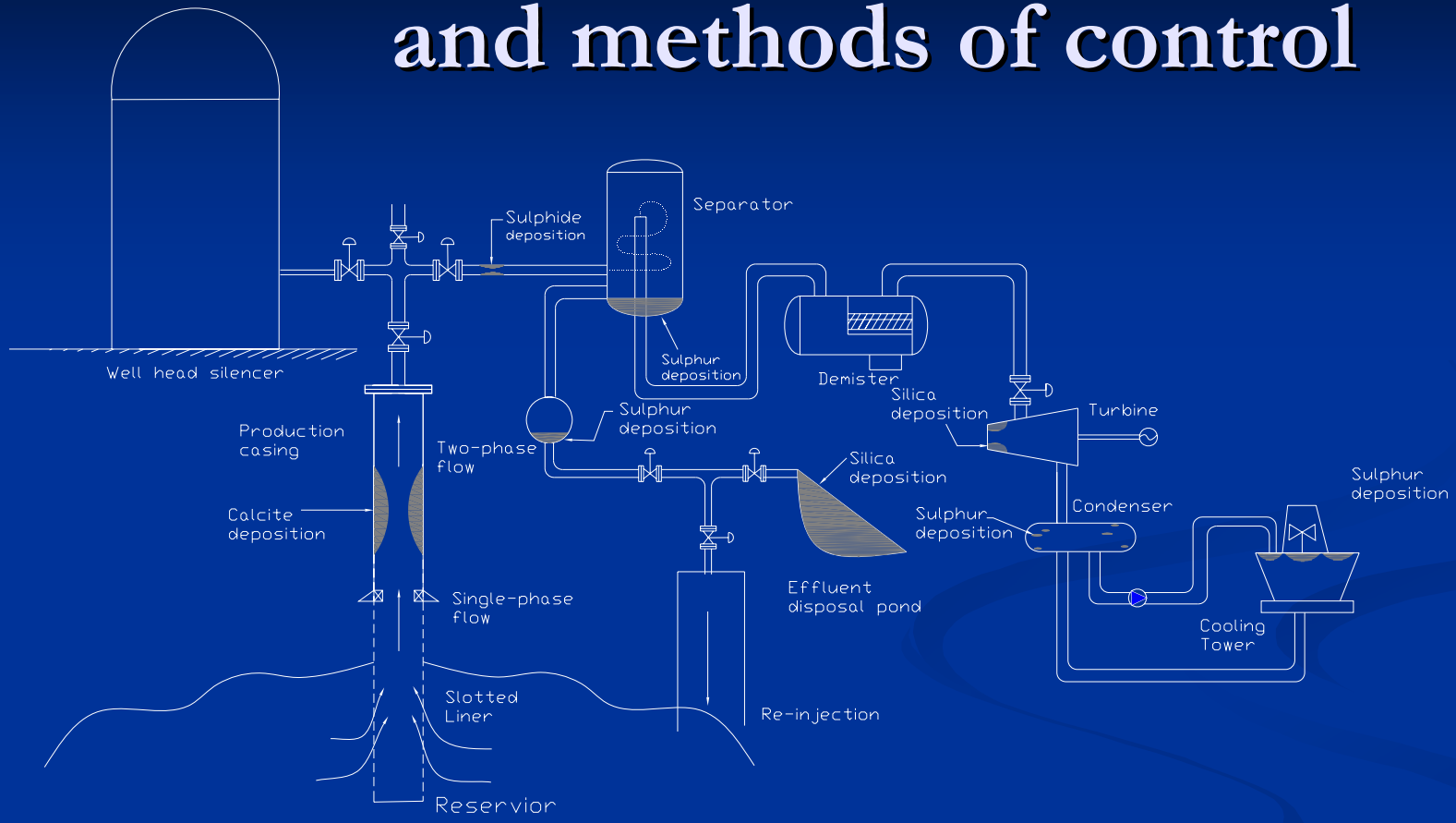
- Dissolved minerals become solid deposits in geothermal fields and equipment that affects exploitation of geothermal resources.
- Depositions are commonly located in reservoirs, liners, production casing and surface equipment.

Possible locations of depositions

Depositions are not uniform so needs to identify their type and locations

- Inside production zone or reservoir
- In production casing or slotted liner
- In surface pipes and equipment
- In turbines and heat exchangers
- In re-injection system

Locations of solid depositions and methods of control



Flow diagram showing common location of solid depositions

Methods of detection of Solid depositions

Using physical measuring

- Go-Devil tool
- Wire basket
- X-Y caliper tool

Type and chemical composition of scales can be analyzed by:

- Microscopy
- X-ray diffraction (XRD)
- X-ray fluorescence (XRF)
- Scanning Election Microscopy (SEM)
- Microprobe
- Wet chemical -analysis

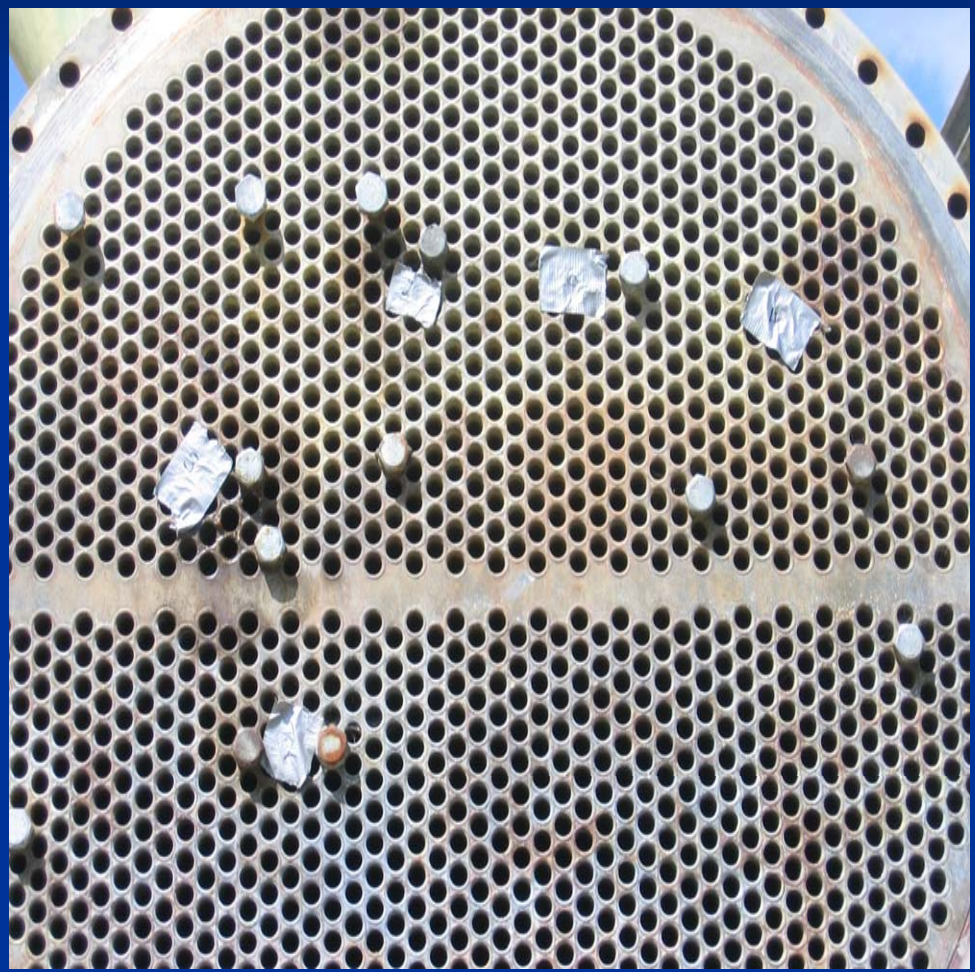
Influence of Solid deposition on power plant operation

- Well output declines (wellhead pressure drops) when solid deposition plugs the flow line inside and outside of the well bore
- Solid deposition reduces the efficiency of the separation of the two-phase fluid separators
- Silica scaling deposits inside inlet turbine nozzles restricts the steam flow which results in loss of turbine power output.
- Condensers can suffer also from sulphure deposition on water distribution plates. This results in the loss of vacuum and power.

Aluto Langano Pilot plant

- Two generating units installed at with 7.3 MW net output. Geothermal combined cycle unit (GCCU) and Ormat Energy Cycle (OEC)
- GCCU is a combined steam turbine in one end and an organic turbine on other end driving electrical generator from the two ends
- GCCU unit is using the steam coming from the two high pressure wells LA-6 and LA-3
- OEC – is entirely organic turbine operating with a secondary fluid Iso-pentane. The design steam flow to the heat exchanger is 29.7 tons per hour, with an inlet temp. of about 150Co and outlet temp.100Co

OEC Heat exchanger failure of Aluto plant



- The heat exchanger is a 316L stainless steel tube
- The heat exchanger is a counter-flow design with steam on the tube side and liquid on the shell-side
- Tubes failed on the steam discharge end
- Pitting occurs on the internal diameter of the tubing
- X-ray analysis shows that silica & sulphr depositions with minor traces of K,Na, Cl & Al
- Brine carryover is suspected to be the cause for the failure

Methods of Controlling Solid depositions

- Mechanical methods – this is using work over drilling rig to remove the hard solid depositions
- Removing scale and debris with continuously flowing of geothermal fluid
- Chemical scale inhibitors- reduce, delay or prevent any depositions. Off course choosing a suitable inhibitors is crucial in applying this method.
- Turbine washing and steam scrubbing by injecting clean water into the incoming steam line before diemister.
- PT control of geothermal fluid at the wellhead
- Control by design (separation pressure)

Conclusion

- Solid deposition (scaling) in geothermal system constraints the design and operation of geothermal power plants
- Well output declines as a result of solid deposition that possible precipitates in reservoirs, in liners and wellbore or production casing
- Application of control methods depends on the type of scale and location of depositions.
- Chemical inhibition system is a promising system technically and economically in combating calcite compared to mechanical methods.

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ALUTO LANGANO GEOTHERMAL PILOT POWER PLANT

Aluto Langano Pilot Power Plant

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