Geothermal Market Opportunity Profile – Corrosion and Scaling

Context

This opportunity profile is one in a series of profiles produced by Optimat Ltd to introduce a specific area of opportunity within the geothermal market for Scottish oil and gas companies. Optimat was commissioned in late 2021 by Scottish Enterprise to assesses the geothermal market opportunities for selected oil and gas sector capability, the outputs of which included a detailed capability and market report and opportunity profiles. Geothermal energy is exploited for both power generation and heating, with many plants already established.

There are several different types of geothermal resource. In our study for Scottish Enterprise, we have focussed on the most prominent current type, namely conventional geothermal, and two emerging types that are expected to demonstrate high growth in near future, engineered geothermal systems and closed loop geothermal systems. The study also explored opportunities within mine water geothermal.

- Conventional geothermal refers to natural formation of a hydrothermal resource where water is heated in the Earth and has become trapped in porous and fractured rocks beneath a layer of relatively impermeable rock. The exploitation of conventional geothermal has focused, to date, on sites where the resource is relatively easy to access, and the resource temperature is high enough for the operation to be commercially viable.
- The term engineered or enhanced geothermal systems (EGS) refers to the practice of creating a geothermal reservoir in hot rock by injecting water into wells to create fractures. The process has generated considerable interest as EGS can be applied wherever there is hot rock at accessible depths, which is nearly everywhere on the planet.
- Closed-loop geothermal (CLG) systems use sealed wells to circulate a heat transport fluid through the subsurface. This eliminates the need for geothermal fluid flow from the reservoir formation to the surface. There is no fluid exchange with the reservoir or surrounding area – the geothermal fluid is not circulated
- Abandoned mines can be used as a geothermal energy resource, using the natural heat contained in the mine water. Heat can be extracted from the mine water by use of water-source heat pumps. As this is a low temperature resource, the heat could be used directly to either support a large heat customer (single building such as school or tower block), district heating or to feed into industrial applications, such as heating greenhouses.

It is widely recognised that Scotland's oil and gas industry is world leading, but that it needs to adapt and diversify as we address climate change and reduce greenhouse gas emissions. Further, Scotland's aim to achieve net zero emissions by 2045 imposes the need for the sector to change quickly. Already a number of oil and gas companies have successfully transitioned into renewable energy activities, particularly offshore wind, and it is expected that national and regional renewable energy hubs and the energy transition zone being developed in Aberdeen will further support diversification of oil and gas companies. However, it is important that additional market opportunities are identified to optimise future opportunities for oil and gas companies

The geothermal energy market is one area of opportunity which has been identified. Here, expertise developed in drilling, sub surface modelling, corrosion mitigation and data analytics could be transferred between the oil and gas and geothermal sectors.

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This opportunity profile summarises the need for corrosion and scaling prevention technologies to support the exploitation of geothermal energy.

The opportunity

The geothermal industry requires new / improved methods for preventing corrosion and scaling in order to reduce plant maintenance costs and increase production efficiency.

Why

Geothermal fluids contain various quantities of soluble species and dissolved gases which frequently result in scaling and/or corrosion of the metallic surfaces in contact with the fluids. This can lead to scale fragments accumulating and clogging pipes, filters and heat exchangers. The problem can have serious economic consequences, such as energy losses, increased capital cost from equipment oversizing, increased pumping costs, increased cost of cleaning and maintenance, loss of production, or even abandoning a production or reinjection well due to clogging.

Figure 1: Mixed silica and sulphide scales in a reinjection pipe

Currently a range of methods are used to prevent scaling and corrosion, from chemical inhibitors to mechanical removal of scales and replacement of heavily scaled or corroded sections. There is need for more effective measures.

A complicating factor is that geothermal fluids vary greatly from site to site (depending on the local geology) so mitigating measures taken on one site may not be so effective on another site. The problem requires a systematic understanding of the phenomena leading to the scaling and corrosion problems and a site-specific solution.

Scale

The problem of scaling and corrosion is widely applicable across all types of geothermal wells and solutions need to be tailored to address the local scale and corrosion problem. This requires a detailed understanding the local conditions, geothermal fluid composition and system operating conditions.

Areas of Need

There are several methods to eliminate or suppress the formation of scale and prevent corrosion in geothermal systems. These can range from measures that interfere with the crystal nucleation and growth process (by using inhibitors) and/or modify the brine chemistry (pH modification).

As geothermal operation extends to greater depths and, therefore, higher temperatures and pressures, there is a need for new solutions.

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Route to Market

The main route market is through plant operators and, possibly, through developers of new geothermal solutions

Project Examples

A German Government Funded Project to Explore Scale Inhibitors in Geothermal Plants

The project was aimed at selected different scale inhibitors and monitoring their performance at two geothermal energy plants in the Upper Rhine Graben. The study found that the combined application of two different product groups, inhibitors for scale prevention and corrosion inhibitors, successfully reduced the total amount of scale. Four partners were involved in the research project, known as SUBITO: BESTEC GmbH, BWG GmbH, VKTA and ZSM GmbH & Co KG. Further details on the project and the findings can be obtained at:

https://www.bestec-for-nature.com/index.php/en/projects-en/subito-de

Further Information

European Federation of Corrosion (EFC) - the EFC is a federation of organisations, Member Societies and Affiliate Members, with interests in corrosion based in Europe and beyond. Its aim is to advance the science of the corrosion and protection of materials by promoting cooperation in Europe and collaboration internationally. https://efcweb.org/

BESTEC GmbH – a German renewable energy company specialising in geothermal, supervising geothermal energy projects from conception to implementation. The company was involved in the German government funded project, SUBITO, where anti-scalant and inhibitor tests were conducted at three of the geothermal plants of the Upper Rhine Graben. https://www.bestec-for-nature.com

Kurita Europe GmbH – an international market leader in industrial water and process treatment, the company supplies a range of inhibitor solutions into the geothermal industry, further details available via https://www.kurita.eu/en/contact