TETRA TECH RPS ENERGY | TRAINING

N731: Reservoir Thermal Modelling for Geothermal Wells

Instructor(s): Kevin Gray

Format and Duration
Classroom - 5 Days

Summary

This course introduces the key concepts of heat transfer and thermal modelling as applied to geothermal energy extraction. It focuses on developing the background knowledge required to understand subsurface thermal processes, system efficiencies, and the role of parasitic loads in geothermal system performance.

Throughout the course, key modelling techniques will be explored, showing the difference between high level conceptual modelling and the detailed feasibility studies required for project development. By the end of the course, attendees will have a practical understanding of geothermal well thermal behaviour and the ability to critically assess geothermal energy models and feasibility studies.

This is an Foundation to Skilled level course designed for professionals involved in geothermal reservoir engineering, well design, and thermal energy extraction.

This course is delivered in partnership with Black Reiver Consulting Ltd.

Learning Outcomes

Participants will learn how to:

1. Understand and calculate geothermal heat in place for resource assessment.
2. Model pressure drops and fluid flow in geothermal wells to optimize system performance.
3. Evaluate parasitic loads and pump power requirements for closed and open loop systems.
4. Optimize geothermal well design based on flow rates, well spacing, and system sensitivities.
5. Use thermal models to estimate production power, efficiency, and decline rates.
6. Recognize key due diligence red flags when evaluating geothermal projects.
7. Apply practical modelling techniques to real world geothermal well scenarios.
8. Differentiate between wellbore and reservoir effects on thermal modelling.
9. Understand how heat transfer principles apply to geothermal reservoir modelling.

Training Method

This is a classroom course comprising a mixture of lectures, discussion, case studies, and practical exercises.

- Instructor led interactive sessions with real world case studies and simulations.
- Step by step guidance on geothermal well modelling, system optimization, and performance forecasting.
- Handson exercises using BR Thermal Models to apply concepts in a practical setting.
- Extensive Q&A sessions to discuss project specific challenges.
- Final system design challenge where participants will develop custom geothermal well specifications.

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Who Should Attend

This course is ideal for:

- Geothermal Engineers & Reservoir Engineers involved in geothermal well planning.
- Drilling & Production Engineers optimizing geothermal well performance.
- Renewable Energy Specialists evaluating geothermal energy projects.
- Project Managers & Investors assessing technical and economic feasibility of geothermal systems.
- Scientists & Researchers working on heat transfer, thermodynamics, and geothermal energy extraction.

Course Content

1. Introduction to Geothermal Thermal Modelling

- Course Introduction
- Overview of course structure and objectives.
- Why thermal modelling is essential for geothermal projects.
- Discussion: Participant expectations and key learning goals.

2. Understanding Geothermal Energy

- The IADC classification of geothermal wells
- The role of geothermal energy in the global energy mix.
- Types of geothermal systems – Open-loop, closed-loop, and hybrid systems.
- The past, present, and future of geothermal energy.
- The value of heat – Economic and technical considerations.

3. Energy Extraction Techniques

- Subsurface geothermal technologies – AGS, EGS, NextGen concepts.
- Surface equipment and power conversion systems.
- Defining thermal power and efficiency parameters.

4. What Can Be Modelled?

- Overview of modelling techniques and workflows.
- Determining the required level of detail for different project phases.
- Differences between high level modelling and feasibility studies.
- The dangers of not understanding the limitations of the software being used.

5. Heat Transfer Principles & Thermal Modelling Fundamentals

- Principles of Heat Transfer

- Conduction, convection, and radiation.
- Comparing conduction vs. convection in geothermal settings.
- The impact of flow rate on heat transfer efficiency.

6. Understanding Thermal Properties

- Thermal conductivity and specific heat capacity.
- Thermal vs. electrical power – Gross vs. net power output.

7. Heat Transfer in Boreholes

- Heat transfer processes within a geothermal wellbore.
- Flow regimes and Reynolds number effects.
- Radial heat flow and thermal resistance in boreholes.

8. Heat Transfer in Permeable Reservoirs

- Different flow types and their impact on heat transfer.
- Modelling approaches for geothermal reservoirs.
- Thermal drawdown and effects of fracture geometry.

9. Heat in Place & System Efficiency

- Understanding how much heat is available in a geothermal reservoir.
- Simple heat in place calculations using Excel based models.
- Estimating first pass production rates from heat in place calculations.

10. Parasitic Loads & Pressure Drop Modelling

- Wellbore effects on temperature and pressure loss.
- Pressure drop calculations in permeable reservoirs.
- Estimating pump power based on system pressure drops.

11. Introduction to the Black Reiver Thermal Model

- Understanding the philosophy and use cases of the Black Reiver Thermal Model.
- Linking flow rate, temperature delta, and production power.
- System sensitivity analysis – Pressure drops, pump power, and fracture flow effects.

12. System Efficiency & Performance Forecasting

- Completion style and production temperature decline.
- Efficiency curves for Organic Rankine Cycle (OCR) power generation.
- Comparing actual system performance to heat in place estimates.

13. Modelling 'Closed Loop' Geothermal Systems

- Understanding system sensitivities, pump power, and decline rates.
- Key performance indicators for closed loop systems.

14. Closed Loop System Optimization

- Pump power and pressure drop adjustments.
- Material selection for high temperature operations.
- Optimizing flow rate and injection temperature.

15. Modelling 'Open Loop' Geothermal Systems

- Pressure drop considerations and pump power requirements.
- Typical decline curves for open loop systems.

16. Open Loop System Optimization

- Pump power, well spacing, and flow rate adjustments.
- Fracture networks and their impact on heat transfer.

17. Project Feasibility, Risk Management & System Design Challenge

- Due Diligence & Risk Assessment
- Key red flags in geothermal feasibility studies.
- Common pitfalls in thermal modelling & assumptions.

18. System Design Challenge – Specifying a Geothermal System

- Participants will develop and present system specifications for:
  - A project requiring an output of 3 MWe.
  - A project requiring up to 1 MWth (thermal energy only).
- Future trends in geothermal energy.
- Best practices for geothermal due diligence and project development.

This comprehensive training course provides participants with practical knowledge, modelling techniques, and critical evaluation skills needed for successful geothermal well thermal modelling. This course can be adapted to client specific geothermal wells and operational challenges.