DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

GEOTHERMAL ENERGY TRAINING AND RESEARCH INSTITUTE
MSc IN GEOTHERMAL ENERGY TECHNOLOGY
END OF SEMESTER EXAMINATIONS
May – August 2020

GET 3008: Reservoir Engineering

DATE: TIME: 3 HOURS

INSTRUCTIONS

1)   TIME ALLOCATED – 3 hours

2)   There are FIVE QUESTIONS in this paper

3)   Attempt only THREE questions

4)   Question 1 is compulsory and is worth 30 marks. The other two are 15 marks each

5)   This Paper will count for 60% of the total score of GET 3008. The other 40% will be earned from CATS and assignments

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Question 1 [30 marks] – This question is Compulsory

a) State and write shorts notes on the different types of geothermal reservoirs that can be classified. *[5 marks]*

b) Explain how permeable zones and fluid types in reservoirs can be identified in practice *[5 marks]*

c) Darcy's law is an equation that describes the flow of a fluid through a porous medium. The law was formulated by Henry Darcy based on results of experiments on the flow of water through beds of sand, forming the basis of hydrogeology. Given the following form of Darcy's Equation,

$$Q = KA\frac{h_1 - h_2}{L} \qquad \text{where} \qquad h = z + \frac{p}{\cdots g}$$

Explain the symbols / letters used. *[5 marks]*

d) Summarise why Geothermal wells (after drilling) need to undergo a test program before they are used. Discuss briefly what information is derived from these tests *[5 marks]*

e) Figure 1 is a Temperature and Pressure profile plot of OW 11A in Olkaria geothermal field. Compare the temperature profiles at 21 days and 68 days heating (i.e., the two curves to extreme right). Briefly describe what can be inferred about the period between the 21st and 68th days. Explain what is happening at depths between about 400 and 700 m *[5 marks]*
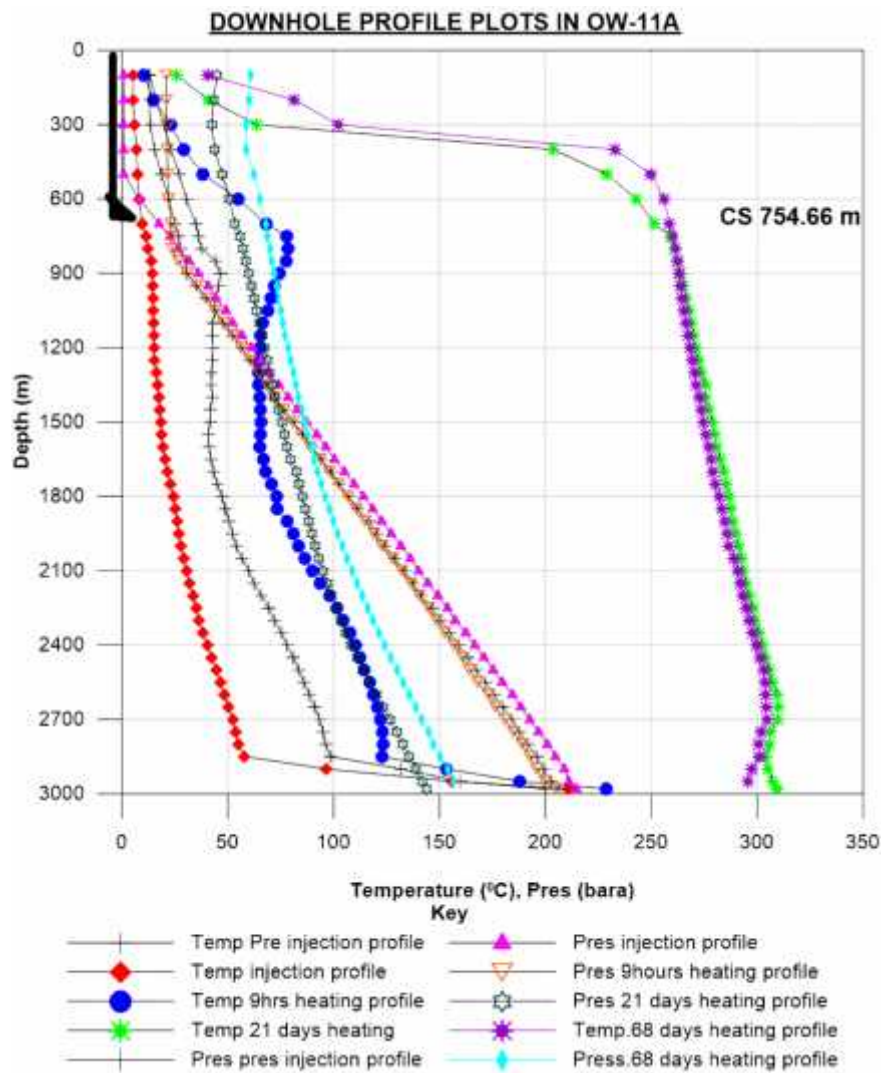
DOWNHOLE PROFILE PLOTS IN OW-11A

CS 754.66 m

Temperature (°C), Pres (bara)

Key

Temp Pre injection profile	Pres injection profile
Temp injection profile	Pres 9hours heating profile
Temp 9hrs heating profile	Pres 21 days heating profile
Temp 21 days heating	Temp.68 days heating profile
Pres pres injection profile	Press.68 days heating profile

Figure 1

f) Reinjection is essential for sustainable utilization of geothermal systems, which are virtually closed and with limited recharge. How can a steam-field engineer determine where and at what spacing to place the re-injection wells within the field with minimum interference impacts? *[5 marks]*

Question 2 [15 marks] – This question is Optional

a) Injection tests accompanied with tracers or Tracer tests, and interference tests are crucial in evaluation of geothermal field properties. Identify the stage(s) of geothermal field development at which either test is most appropriate. Explain your answers. *[5 marks]*

b) Discuss the main reasons for conducting Tracer Tests. *[5 marks]*

c) Tracer return rates, both in time (speed) and volumes recovered are important results in tracer tests. Explain their implications. *[5 marks]*

Question 3 [15 marks] – This question is Optional

a) Write short notes describing two roles or activities for a reservoir engineer in each of the three stages of Exploration, Appraisal Drilling and Exploitation. [15 marks]

Question 4 [15 marks] – This question is Optional

Imagine you have been appointed as Chief Engineer of the newly commissioned Olkaria 5 (172 MWe) Geothermal Power Plant. Discuss what activities / measures that you plan to put in place to keep it supplying steam to power plant for a long period of time. Include in your discussion scenarios such as steam output decline, pressure decline, re-injection, changes in enthalpy. *[15 marks]*

Question 5 [15 marks] – This question is Optional

a) Figure 2 is a Temperature log during warm-up period from a geothermal well. There is no flow from the well.
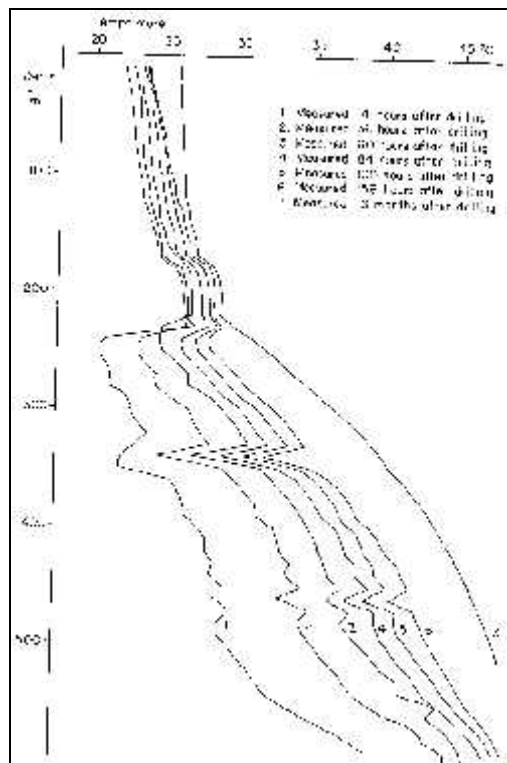

Figure 2

Identify TWO main probable feed/loss zones and explain your choice. *[5 marks]*

b) Figure 3 shows the production history of Chingshui geothermal field, Taiwan. It shows the field deliverability of geothermal fluids and the power output at Chingshui from 1981 to 1993. There was no re-injection of spent geothermal fluids during that period. Offer possible explanations for the observed trends from 1981 to 1993. *[5 marks]*
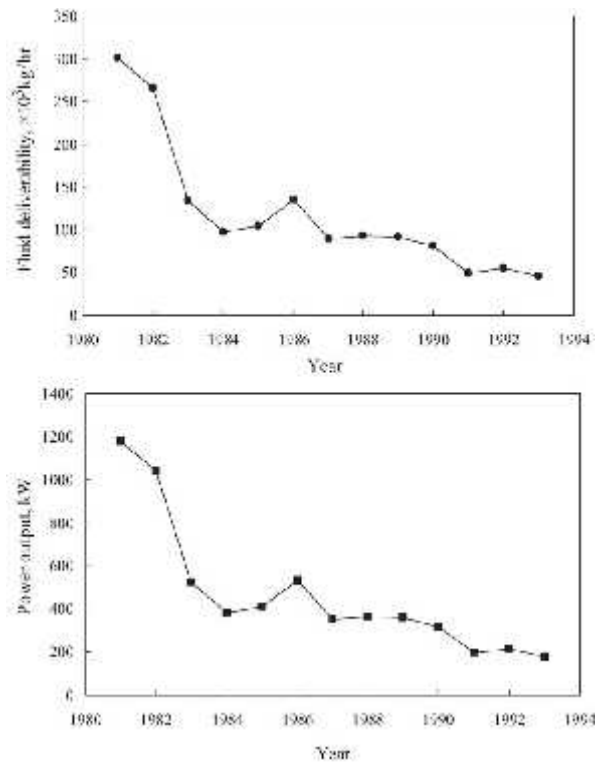
Figure 3

c) Write brief notes on what activities can be included in an integrated reservoir management. *[5 marks]*