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Application of Thermal Modeling in Estimating of Correct Geothermal Gradient in Bangestan Reservoirs in Dezful Embayment

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SUMMARY

Abstract:

This study was focused on calculating the geothermal gradient and checking it by thermal modeling in Asmari & Bangestan Reservoir in the Dezful Embayment, Iran. Temperature data are obtained in boreholes and then use for calculating the geothermal gradient. But sometimes determining of correct geothermal gradient due to some factors such as lithology variation and a little error in temperature readings is impossible. Also some wells show a geothermal gradient higher than others. For solving of these problems we utilized thermal modeling and organic geochemistry.

Introduction

Oilfield geothermal gradient study is one of the important parameters that has a lot of application in oil industry. Geothermal gradient study is used for designing of mud composition, drilling, cement, packers, well electronics devices and drilling pipe, well completion, tectonic processes, and estimate of maturation degree, timing of oil generation, oil & gas accumulation setting in organic geochemistry. This study has done to determine Bangestan reservoirs geothermal gradient in different oilfields.

Discussion

The temperature underground normally increases with depth below the surface, and the rate of increase with depth is called *geothermal gradient*. Values for geothermal gradient vary from about 10 °C/km up to 50°C/km or higher, with average values being roughly 25 °C/km(Barker1996).

Effective factors on geothermal gradient variation are

- Lithology
- Structural phenomena
- Salt domes

Methodology

The temperature data are obtained from temperature survey forms, and then were entered in Excel software for calculating the geothermal gradient of Asmari and Bangestan reservoirs. In some wells there are only 2-3 temperature data from a formation (reservoir), and also there is no temperature reading exact from top and bottom of a formation, as result of, calculation of geothermal gradient is very difficult and even may lead to error. Also geothermal gradient of some wells higher than others, which are needed to evidence, in these cases the best way/tools is using thermal modeling and indicator of organic geochemistry.

Thermal Modeling

Oil generation modeling is indirect method for, determining of maturation depth, timing of oil generation and source rock evaluation. This method proposed by Lopatin in 1971, that takes into account both time and temperature in calculating a cumulative thermal maturity for sedimentary organic matter.

The Lopatin method generates a dimensionless number, called the time – temperature index (TTI). The stages of oil and gas generation according to TTI are:

TTI = 15 is onset of oil generation, TTI = 75 is pick oil generation, TTI = 160 is end oil generation. Correlation between TTI and Tmax, Ro has given in Table 1 (David Newell 1997).

Also Easy Ro is a method for calculating of vitrinite reflectance by mathematical equations that was presented by Sweny and Burham in 1990. There is some software for this purpose that estimate maturity versus depth based on TTI (Lopatin method) or Easy Ro. We used P.B.M software in this way, thickness and age of layers associated with lithology percent, surface temperature, geothermal gradient are entered as input, result in software calculate maturity versus depth (its may be checked by measured vitrinites), temperature versus depth and layers or formations geothermal gradient. Software calculates maturity, temperature and geothermal gradient of layers according to their thermal conductivities.

To check geothermal gradient by thermal modeling

Conversion of organic matter to oil and gas called maturity that's depends on time and temperature having liner relationship with time and exponential relationship with temperature (Barker 1996).

At first the temperature data were entered in Excel software and Calculated geothermal gradient of Bangestan reservoirs.

But we faced to some problems such as a little reading of a formation (reservoir) (Table.1), abnormal geothermal gradient derived from calculation (Table.2), and also we saw/noticed that as a little changing in top or bottom temperature of layers, lead to remarkable changing in geothermal gradient, for example if record 118.8 °C instead 117.8 °C (related to 3991m from table 2) Sarvak geothermal gradient will be 9.87°C/km.

Abteymur		
Formation	Depth (m)	Temperature (°C)
Aghajari	305	29.6
Aghajari	610	38.5
Aghajari	914	46.9
Aghajari	1219	55.5
Mishan	1524	64.2
Gachsaran	1829	72.4
Gachsaran	2133	80.9
Asmari	2438	86
Pabdeh	2743	93.7
Pabdeh	2895	98.6
Gurpi	3048	102.6
Ilam	3200	106.6
Sarvak	3353	111.3

Table.1 Temperature survey in one well of Abteymur(there is one reading of Ilam

Ahwaz		
Formation	Depth (m)	Temperature (°C)
Aghajari	334	59.6
Aghajari	944	72.3
Mishan	1553	85
Gachsaran	2163	91.7
Gachsaran	2468	99.1
Asmari	2772	106.3
Pabdeh	3077	111.6
Gurpi	3382	113.6
Ilam	3534	115.1
Sarvak	3687	115.8
Sarvak	3763	116.4
Sarvak	3915	116.9
Sarvak	3961	117.2
Sarvak	3991	117.8

Table.2-Abnormal geothermal gradient
Sarvak geothermal gradient = 6.57 °C/km

For solving the problem we used thermal modeling.

Figure1 - Predict temperature V.s depth graph associated with measured data from one well of Abteymur oil field

Figure 2 - Predict temperature V.s depth graph associated with measured data from one well of Ahwaz oil field

Figure 1 shows that software can predict geothermal gradient formations (including Ilam and Sarvak reservoirs) with very much consistency to measured temperature, while with having temperature from one point of a well, estimating of geothermal gradient through calculation is impossible. Also, figure 2 represent erroneous temperature reading in the first major part of the well, correct temperature graph (predicted) and geothermal gradient. Noteworthy that deviation from the correct temperature in top of Sarvak was leading to error, so that Sarvak geothermal gradient, 6.57 °C/km was calculated.

Conclusion

- 1- The proposed method is a new way for checking the calculated geothermal gradient with a high accuracy.
- 2- By this method geothermal gradient estimating for formations even without any measurement is possible. By this method can predict temperature and geothermal gradient of intervals which don't have measured temperature.
- 3- Using thermal modeling can get a lot of information such as maturation depth, onset of oil generation, sedimentation rate.
- 4- By this software using geothermal gradient and vitrinite reflectance calculation of eroded thickness of layers is possible.
- 5- Formations geothermal gradient depends on Lithology, shale, marl and sandstone have maximum, salt, anhydrite and limestone minimum geothermal gradient respectively.

Acknowledgments

The author gratefully acknowledges the contribution provided by National Iranian South Oil Company (NISOC) to the realization of this work.

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