IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG)
e-ISSN: 2321–0990, p-ISSN: 2321–0982.Volume 3, Issue 6 Ver. III (Nov. - Dec. 2015), PP 46-49
www.iosrjournals.org

Analysis of Difficult Points of Explanation and Handling of Isotope Intake Profile

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Abstract : *isotope intake profile logging has been widely used in oil field due to its low cost, simple operation, intuitive effect and other significant advantages. This paper analyzes the doubtful points and difficult points in the explanation of isotope intake profile logging, the practical significance of the curves and internal causes for the contradiction between each curve, which can guide and interpret the practice and help to improve the rationality and accuracy of interpretation results.*

Keywords: *isotope, well temperature, flow, relative water absorption.*

I. Preface

Isotopic trace injection profile logging is to inject the isotope tracer into the well under the condition of normal water injection in injection well, with the inflow of the injected water, tracer is filtered on the rock surface of the injection water layer, then tracer curve is measured with natural gamma logger, on the curve shows the difference of radioactivity intensity and the amount of water injection are in positive proportion, and relative water injection volume in each layer can be obtained[2]by comparing natural gamma curves measured before and after the injection of tracer[2].

Due to the different underground geological conditions, different structures of pipes and columns, and random factors in the process of well logging, etc., the measured curves are different. In the interpretation process of isotope injection profile, a variety of factors also will be encountered. How to analyze the relationship between curves is the premise of the rationality and accuracy of the interpretation, also the priority before the explaining engineer.

II. The Influence Factors Of Isotope Curve

As is known to all is that isotope curve affected by properties of radioactive microsphere particle is usually influenced by contamination, entering the layer, settlement and other factors. In addition, we will find that the isotope curve is also affected by other aspects in the actual interpretation and handling process, because they are concealed, which are not easy to be found.

The injection volume of this well is 25 volumes, 13 volumes are distributed on the spot measurement flow upwards, and 12 volumes downwards. It can be seen from the isotopic curve (red, blue, green, purple) change that water enters in the upper perforating interval, but isotope curve has high amplitude and sinks fast near the choke, which piles up near the middle top in the packer, and presents a small peak abnormality. Around the up and down, continuous flow has no obvious change, proving the water absorption in upper injection perforation is very few. So it is relatively proper to explain it with continuous flow (Figure 1)

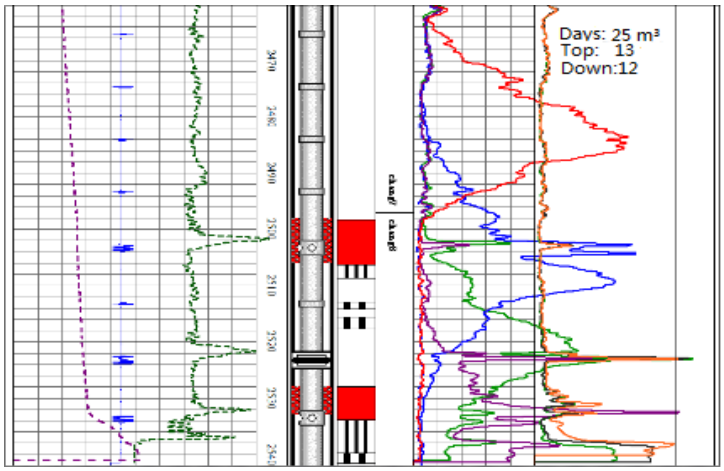

Figure 1 Curves of A1 Well Injection Profile Logging

III. The Characteristics Of The Flow Curve And Its Influencing Factors

Whether it is electromagnetic flowmeter or ultrasonic flowmeter, the measured physical quantity is the fluid velocity which is further converted to the flow of oil tube or casing. Because the fluid velocity is often influenced by pipe and column tools, wall scaling in oil casing, speed change and other factors, the curve is not often a straight line. Therefore, it is generally to select the average value when the continuous flow curve is referred to calculate relative injection amount.

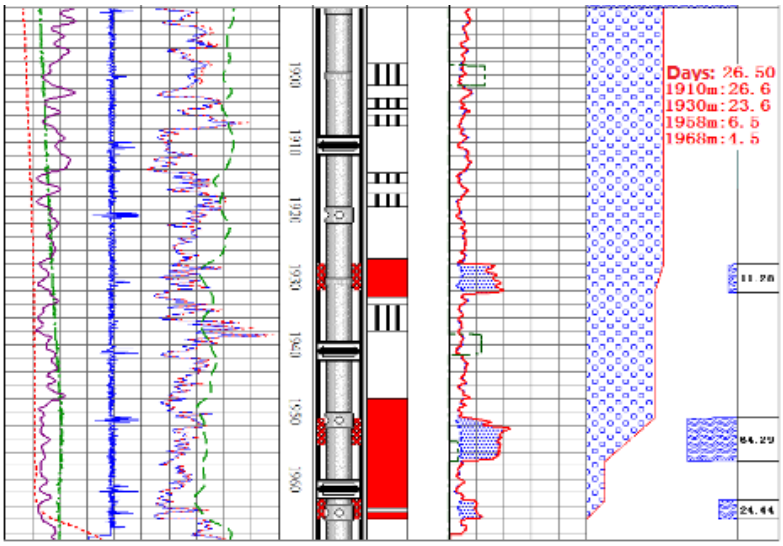

Figure 2 Design Sketch of A2 Isotope Intake Profile

The total flow measured with ultrasonic flow meter is 26.5 volumes, 4.5 volumes is distributed downwards. The flow calculation of upper and middle distribution is simply, and the downward distribution of flow is selected from 6.5 volumes and 6.5 - 4.5 = 2 volumes. The encountering resistance of this well is close to the lower water distributor, the injection water entering the water distributor will drop a certain distance due to the effect of the gravity, that is to say, the downward flowing water within the tubing will cause a disturbance to the dead zone, and the greater the downward water flowing, the greater the disturbance. The ball seat is not found missing, and the well temperature curve also shows the change area is the dead zone, so the flow rate of perforated interval distributed downwards should be 6.5, and the relative water quantity should be 24.44% (Figure 2).

IV. The Features And Influencing Factors Of Well Temperature Curve

Because water injection layer is affected by low temperature injection water for a long time, the temperature curve has obvious difference with non-water injection layer. The gradient of temperature change in water injection layer is related to the injected water temperature, injection speed and the depth of the injection strata. For the concrete injection well with simple pipe and column, the section of abnormal temperature curve often has large water quantity [1].

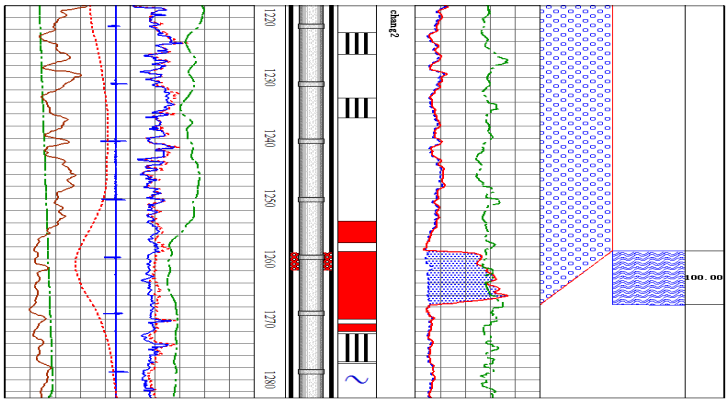

Figure 3 Design Sketch of A3 Isotope Intake Profile

Under this shaft, the tested well temperature curve (Red dotted line) can clearly reflect the fact that because of long-term water injection in reservoir, the temperature change characteristics appear obvious negative anomaly compared to surrounding rocks (Figure 3).

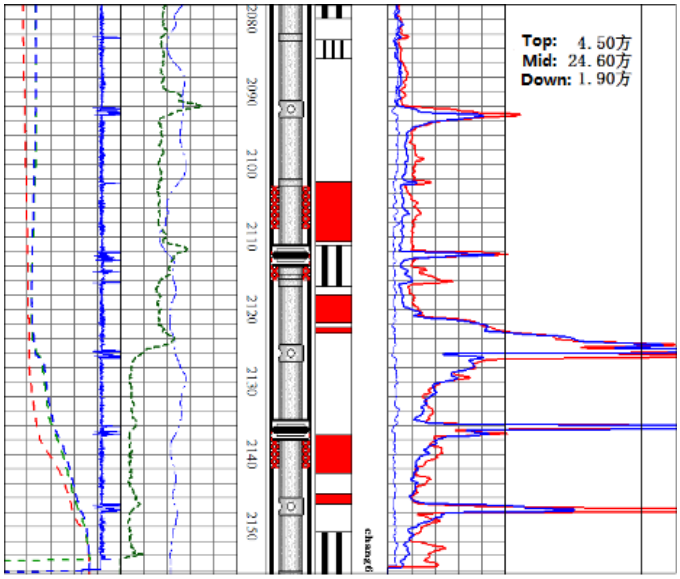

Figure 4 Design Sketch of A4 Isotope Intake Profile

The curve relationship of the well is complex, and different people even have the opposite conclusions and advice (Figure 4). The daily injection volume of the well is 30 volumes. Spot measurement flow and continuous flow are very conforming, namely most of the water enters into the middle, so the flow curve should be reasonable and true. If relative injection is calculated according to the flow rate, 2140 meter layer only sucks 1.9 volume water, accounting for 6.13% of the total injection. But the well temperature curve (Red dotted line) has anomaly amplitude at the 2140 meter layer, which seems to have contradiction with flow curve. Many people will get a conclusion that the water enters into the annulus through the middle distribution due to the leakage of the lower sealing, and then enters 2140m injection perforation. But isotope curve has obvious accumulation near the packer, meanwhile the flow temperature curve (red dotted line) starts to have obvious slow rise under the middle distribution, and the rising amplitude increases significantly at the perforated

interval. Thus it can be inferred that the oil tubing and annulus have no large amount of injection water flowing, leakage conclusion has no conclusive evidence. Then look at the two static temperature curves (blue and green dotted line), the curves begin to rise significantly in the middle distribution and the lower packer and began gradually closing to the geothermal gradient, the entire has obvious rising under the middle distribution compared to the flow temperature curve, the temperature is recovered quickly. We know that the layer with its temperature recovered quickly is the layer which has small water sucking or no water absorption. So it can be said that 2140 meter section perforation interval can absorb water, but not a lot of water and it is reasonable to explain with flow.

V. Conclusion

Isotope injection profile logging is a kind of dynamic monitoring method which is popular earlier and relatively simple, however, it often cannot cause people's attention due to the heavy task. But the depth of the curve is accurate, conclusion is straightforward, and more reliable water injection profile information can be provided after comprehensive judging of interactive relationship of every curve. Meanwhile, in the processing and interpretation, the well specific conditions of the well and the influencing factors shall be analyzed to obtain the most scientific and reasonable conclusion.

References

Examples follow:

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[2] Guo Haimin. An Introduction to Production Logging [M]. Beijing: Petroleum Industry Press, 2003:625-675