

ISSN 0970-1214

RNI No. MAHENG 13446/13/1/2013 - TC

oilasiajournal

HIGHEST CIRCULATED PETROLEUM & ENERGY JOURNAL FROM INDIA

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Reservoir Monitoring to Manage Oil and Gas Production through Carbon Oxygen Ratio and Sigma Measurements using Halliburton RMT™ Tool

INTRODUCTION

Reservoir monitoring is one of the essential and routine services in oil and gas fields. This is required for mid course correction to optimize production and maximize recovery, as the field depletes with production. Reservoir monitoring helps in delineating current status of the reservoirs by pinpointing formation fluid contacts, breakthrough zones due to flooding, and bypassed hydrocarbon reservoirs through evaluation of current oil and gas saturation. Yielded saturation values are independent of formation water salinity and hence the technology is well suited in fresh and varying formation water environment, where conventional openhole log interpretation fails. Halliburton RMT™ tool addresses all these issues robustly.

HLS Asia Limited (HLSA) an Indian Joint Venture of Halliburton Energy Services Inc., USA have been providing this service along with all type of Wireline Logging and Perforation including Tubing Conveyed perforation, and Slickline Services, Data Processing/ Interpretation, and allied services in different terrains/ formations to various OIL & Gas companies.

TECHNOLOGY

RMT is a dual detector pulsed neutron spectrometry tool that in houses a pulsed neutron source, called Minित्रon and two large size bismuth germinate (BGO) scintillation detectors, which yields high gamma ray count rates with good spectral resolution. The pulsed neutron source— Minित्रon, releases a burst of 14 Mev neutrons in all directions, which upon neutron-nuclei interactions yields gamma rays due to two types of reaction: in-Inelastic and capture modes.

The gamma ray energy spectra resulting from inelastic and capture interaction is recorded for evaluation. Reactions due to inelastic scattering are used for the carbon-oxygen measurement. While Neutron capture reactions are the basis for sigma measurements.

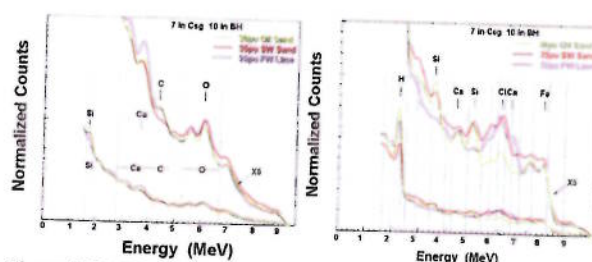
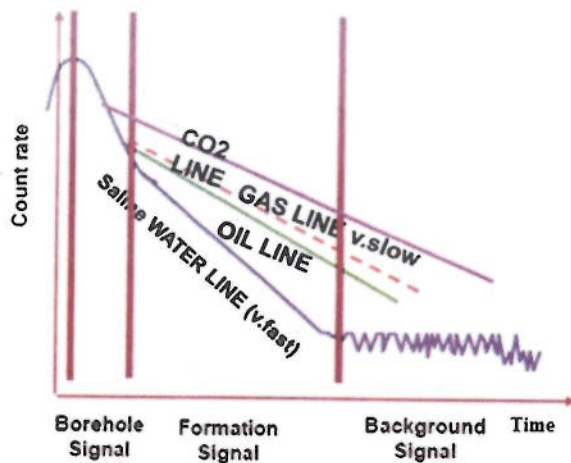


Figure 1&2. RMT™ Inelastic and Capture Spectra - through-tubing C/O system.

In C/O mode, the tool measures Carbon and Oxygen content, Carbon is directly related to hydrocarbons and Oxygen to water. The ratio of Carbon to Oxygen therefore represents the current hydrocarbon saturation in the formation. Higher C/O ratio signifies higher hydrocarbon saturation.

In Sigma mode, the tool measures the decay rate of capture gamma rays and this is quantified as "Sigma"— a property which has dimensions of length⁻¹. Thermal neutrons (low energies) are very susceptible to capture by chlorine. Higher chlorine content yields faster decay rate and low chlorine content slow decay rate. This variation in gradients enables sigma measurement— discriminates between water, oil, and gas bearing zones in very saline formation water environment as shown in Figure 3 below.



In C/O and Sigma mode, ratio of near to far detectors counts is roughly similar to open-hole density and neutron porosity log respectively. These two features make this technology unique, favorable and advantageous to the industry for fluid type recognition in addition to quantifying saturation behind casing.

CASE STUDY

The example illustrated is a case of fresh formation water having salinity 3600 ppm, and poor contrast between water and hydrocarbon bearing formation. The objective of RMT was to establish presence of hydrocarbon in zone A, find the current saturation value and confirm the fluid

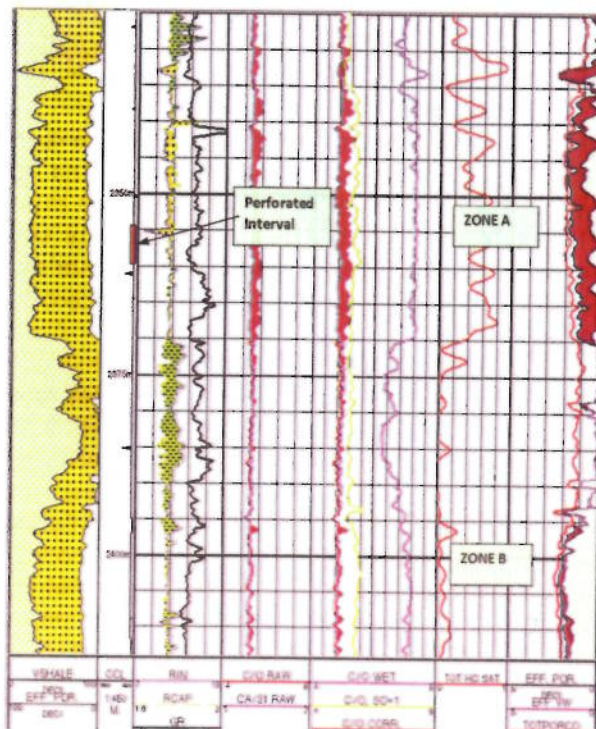


Figure 4: RMT results show hydrocarbon saturations in upper sand zone A.

type, whether it is gas or oil?

To tackle this problem RMT job was undertaken in inelastic and sigma mode. C/O mode data depicted in Figure 4 showed presence of hydrocarbon having hydrocarbon saturation 50 - 60% in the upper sand zone-A vis-a-vis the bottom reference sand, which is water bearing. Sigma measurement used for identifying fluid type did not confirm to gas presence in zone -A, Figure 5 and is therefore affirmed to be oil bearing, which is validated through conventional test.

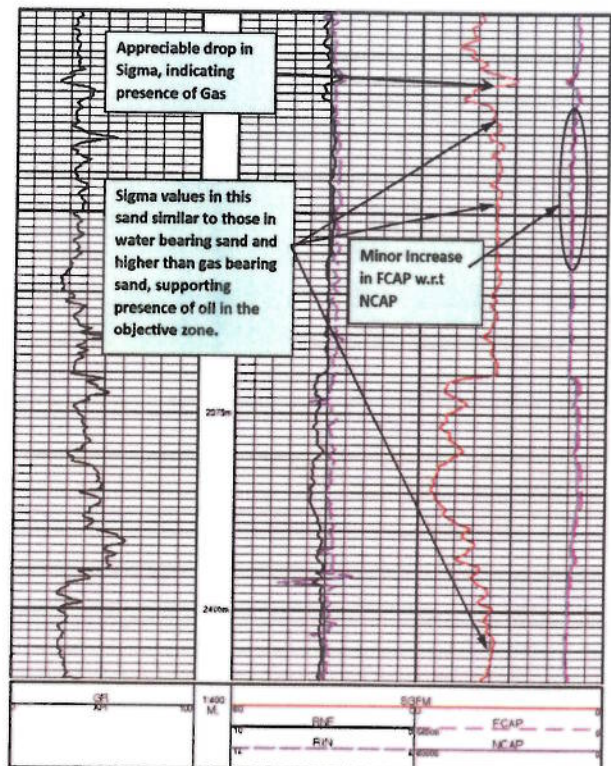


Figure 5: Sigma log shows no sign of gas against Zone-A.

RESULTS OF THE CASE STUDY

Zone - A is identified as oil-bearing (and not as gas bearing as thought earlier based on openhole data) having current oil saturation 50 - 60%. RMT derived evaluation thus crossed the hurdle of low formation water salinity and poor resistivity contrast between hydrocarbon and water bearing zones.

CONCLUSION

RMT™ tool has been effectively utilized by various clients in Assam, Gujarat & Rajasthan field to improve recovery, identify missed zones, identify lithology, rehabilitate wells, increase production, and save on the cost. The tool evaluates the time lapse performance of hydrocarbon producing reservoirs without pulling out tubing from the

well. Tool application can further be stretched: to evaluate efficacy of gravel-packs via silicon activation, detect water flow inside or outside the pipe, analyze production profile details using additional information from complete

production logging tool sensors. RMT™ data has paid off clients produce extra barrels of oil, which under normal circumstances in absence of this technology could possibly have been lost.

Yash Malik takes over as Chief Corporate Planning

ED Yash Malik has assumed the charge as Chief Corporate Planning, ONGC at New Delhi on 28 January 2016. Malik's overall knowledge of the hydrocarbon sector and his diverse experience in helping key corporate positions through an illustrious career will be of great relevance to the organization at the corporate planning and strategy level as ONGC negotiates a tricky passage through a highly volatile and uncertain energy landscape.

Prior to this assignment, Malik was the Asset Manager of Ahmedabad Asset beginning 1 July 2014. During this period, he helmed and led the Asset team from the front in launching several important initiatives that has proven to be of immense significance to the Asset in terms of sustaining production as well as improving productivity and cost efficiency in an environment where oil and gas producers have been seriously handicapped by the prevailing extremely low crude oil prices.

Gamij Redevelopment Project, the only onshore project in stage-gate projects identified by ONGC management, was approved and set in motion during his tenure as the Asset Manager of Ahmedabad. In today's time when both cost and field developments are challenging, horizontal fracking, now a world-wide used technology in mature fields, was successfully introduced in Gamij fields. In addition, ample impetus was also lent to other projects that were crucial to Ahmedabad's performance; noteworthy among them being

the commissioning of five ETPs and the resolution of long pending action of taking over of new vessels with latest systems at Desalter Plant. Operational safety and cost-effectiveness were the other focus areas of Malik at Ahmedabad.



First day in office

This is particularly important in a global energy environment that has grown increasingly sensitive to a company's performance in the domain of HSE and Sustainability as well as capital discipline. The laying of pipelines, implementation of cost-effective "Make in India" SRP Monitoring System and start of pad-drilling can be viewed as results of this priority-defined approach.

A Production Engineer par excellence, Malik has around thirty-four years of rich and varied experience that spans the multiple facets of ONGC's domestic as well as international oil and gas business. In the overseas arena, he had served as the Country Manager at ONGC Videsh' hydrocarbon property in Sudan and also held important positions at Imperial Energy in Russia. Furthermore, his stint as the Chief of ONGC's Marketing division was remarkable for the formalization of ONGC's trade relationship with the Oil Marketing Companies through the signing of Crude Oil Sales Agreement (COSA) between ONGC and the likes of IOCL, BPCL, HPCL and MRPL.