9th Biennial International Conference
& Exposition on Petroleum Geophysics

"HYDERABAD 2012"

P-122

Value Addition through Casing Integrity Evaluation using Multi Finger Imaging Tool (MIT)-Case Studies of Assam Asset

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Summary

The productive life of a well can be affected by deterioration of the casing integrity which can be due to corrosion, casing damage during drilling/ work over. Scale build-up can also reduce production. Remedial measures can be executed if the nature of problem is diagnosed . One can receive early warning of a potential problem and obtain data for determining a specific restoration program by running the casing inspection suite. Measurements from multifinger calipers determine the condition of the casing within a well.

In Eastern region, where the wells are more than 60 years old, overall condition of the casings may not be good as a number of work over jobs have been necessitated and subsequently executed on these wells for improving their performance. Increasing water cut has been a major problem in wells of Rudrasagar, Lakwa and Geleky fields. Water cut decreases the production substantially and if the source of the water is not properly identified, the output from that zone in the well could be permanently affected. There have been many cases of increased water-cut in the expected oil bearing sands. This could be due to numerous reasons, which may be identified with the help of different methods. The common reason for deterioration of casing condition is parting, severe corrosion, massive scaling etc. leading to unwanted water entry.The increase in water production also acts as a catalyst for futrher deterioration of well casing integrity.

Multi Finger Imaging Tool(MIT),is one of the tools available in oil industry for evaluating casing integrity. Analysis of recorded data by MIT may help in formulation and implementation of immediate remedial action plan which may result in increased production with less water flow.

The present case studies deal with the application of Multi Finger imaging tool to identify exact problem of the well and to formulate a plan for remedial action. MIT tool having 24 fingers is a state of art electromechanical slim hole tool (1-11/16" dia) with very high resolution (0.005") and very high accuracy (0.020") which measures 24 caliper values translating to 24 radius measurements of the entire circumference. It works on the basic principle of LVDT (linear variable displacement transducer) in which no electric contact across the transducer position sensing element which for the user of the sensor means clean data, infinite resolution and a very long life. This makes the MIT- very reliable and dependable tool.

MIT survey is regularly being carried out in those wells of Assam Asset where severe problems are faced in execution of planned work over jobs.

In the present paper, three case studies are elaborated, where unplanned MIT logs were recorded during complications of work over job operations. In two wells, based on the findings of recorded MIT logs, remedial measures were undertaken resulting in total oil gain of 8m^3/day (4m^3/day in each well). Whereas, in the third well, one casing collar was found slipped , thereby making work over job not feasible. Subsequently, the rig was released for next location without wasting any more time.

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Introduction

The prime use for the Multi Finger Imaging Tool is to record data to maximize production or recovery from the field, either through appropriate remedial work on a well or by providing information to optimally manage the field. MIT logs provides information about the following isssues:

- Corrosion
- Scale Build Up
- Erosion Damage due to well flow
- Mapping Perforations
- Confirmation of Well Completion Items
- Milling / Drilling Damage

Methodology

The MIT tool has been designed to provide the most accurate casing/tubing caliper measurements in the industry. The high quality of the data allows for 3 dimensional imaging of the casing/tubing which becomes very easy for the end-user to understand the problem and easy identification translates into quick and better remedial solutions. 24 internal radius readings with high resolution and accuracy determine the casing/tubing structure and then is processed to 3-D image of the well. This 3-D image can then be used to assess corrosion , casing/tubing wear, casing deformation, drill string damage, perforation mapping, quantification of scale build up. This tool could further be used to confirm that the perforations carried out have been at correct intervals.

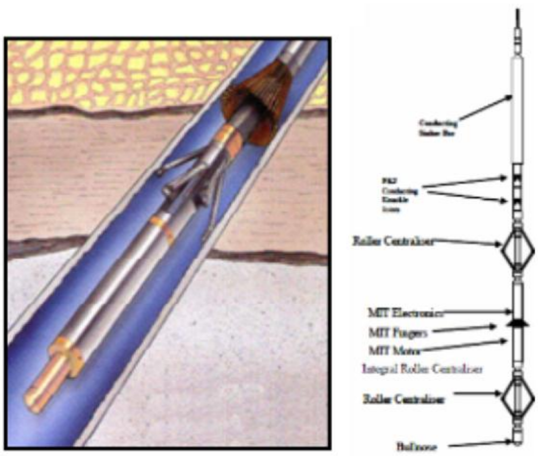

Figure I: MIT Tool Photograph & Design

Tool principle

Multi Finger Imaging Tool (MIT) consists of 24 fingers, each of 7" length. Tool OD is 1 11/16" with temp rating of 350˚F and pressure rating of 15000 PSI. It measures from 1 ¾" to 7".(Fig.I) MIT has two primary sections namely Sensor section and Motor Section. Both of these could be further classified into mechanical and electrical sections.

The sensor section consists of the sensor head, finger section, and sensor electronics. The sensor section consists of an array of 24 fingers (Each finger length 7"), which track the surface of the wellbore. Each finger is free to move independently. The Sensor Head assembly houses all the sensor coils, as well as providing structural support for the sensor electronics. The sensor head provides the pressure barrier between the actuators and the sensor coils. The sensor coils are attached to the Coil Interface PCB, mounted directly on the sensor head itself. This PCB applies the drive signals to the sensor coils and selects the finger to be sampled. The sensor electronics are then attached directly above. A temperature probe is also mounted at the sensor section to allow the software to correct for temperature drift. Within the sensor electronics there are two additional sensors, both providing inclination and deviation information. The MIT makes 24 independent radius measurements, using an array of 24 LVDT (Linear Variable Differential Transformer) sensors. These sensors convert the linear displacement, provided by the fingers and actuators, into an electrical measurement of the finger position. It is because of this LVDT sensor that the tool has high resolution and accuracy. The motor section has electronics to control motor opening and closing and the motor itself rotates the lead screw from which linear drive is transferred to finger mechanism via a single shaft. The motor travel is limited by using two normally-closed micro-switches. For the safety of calipers in a system failure the tool auto closes automatically when the communication to the tool is lost provided tool-bus has power.

Data Processing Through Well Integrity Visual Analysis (WIVA)

The tool needs to be centralized for better readings, especially in inclined wells. The 1st step in data processing is to apply temperature corrections to the readings to do away the effect of temperature. Then WIPER (Well Integrity Processing Evaluation and Reporting) applies more rigorous centralizing algorithms and identifies the nominal I.D. and anomalies in a relative scale.

Graphical visualization is an excellent way to communicate the vast amounts of complex data acquired from the Multifinger Imaging Tool (MIT). By combining information from the MIT, images can be created on a computer screen in three dimensions. Color schemes, meshes, arrows and numerical data can be added to help to understand the structure and condition of the well. In particular, the dimensions and type of completion can be shown together with the location and magnitude of any damage. WIVA has been developed to generate 3D views of casing surfaces in order to "see" perforations, pipe damage, and other anomalies. WIVA is a very powerful Microsoft Windows® based software package that has the ability to simultaneously view data from the casing inspection tools of the Well Integrity Platform - MIT. A variety of functions in the software allows to view the pipe in a number of ways in order to assess anomalies and areas of damage. Internal and external casing data can be displayed together or separately; grid references applied; 3D pipe views split into sections and rotated 360°. The output of the WIPER is used to form the 3-D image of the well in WIVA. The 24 caliper reading of the MIT tool provides the image after processing which is then used to visually see the 3-D image of the well.

Case studies

Well "A"

Well "A"drilled in May-1997 in Rudrasagar field was completed in BMS sand in the interval X366.0– X369.0m. On activation, well came on self-flow but well ceased due to 100% W/C. In March 2010, WSO by Polymer (PHPA) followed by CSQ was carried out,but the job failed. The hole was cleared from X365.0 to X390.0m. C/R was set at X365.5m. Stabbing tool was lowered and C/R was stabbed. H/T was found ok at 2200 psi. The tubing was stabbed out and static loss was observed above C/R. HEC pill was placed but static loss could not be arrested.Well was completed with GLVs and packer.

In September 2010, work over was planned out to arrest water cut and to open the interval X360.0 – X363.0m. The well could not be subdued even after several attempts, there was huge loss in the well. PLT was attempted to find the causes for fluid loss during subduing the well. Tubings were lowered with pup-joint and scrapper to clear the hole up to cement retainer at X365.5 m. which was duly tagged and a thorough circulation was carried out. PLT tool could be lowered only up to X360.0m as there was scrapper at the bottom. Recorded temperature logs did not reveal any temperature anomaly. However, with pup- joint signature it was established that C/R top is at X365.5m.

Tubings were subsequently pulled out of hole and well was handed over for casing inspection survey which was carried out in the interval X365.0 to X300.0m. On analysis of Multi-finger Inspection Tool logs(Figs.II & III), it was found there existed holes in the casing in the interval X361.5 – X363.5m., which was the main source of fluid loss in the well. Subsequently, CSQ was carried out in the interval X361.5 – X363.5m and finally well was completed in the interval X360.0–X363.0m as per plan. On activation, the well produced, QL - 10 m3/d, W/C - 60%, Qo - 4 m3/d.

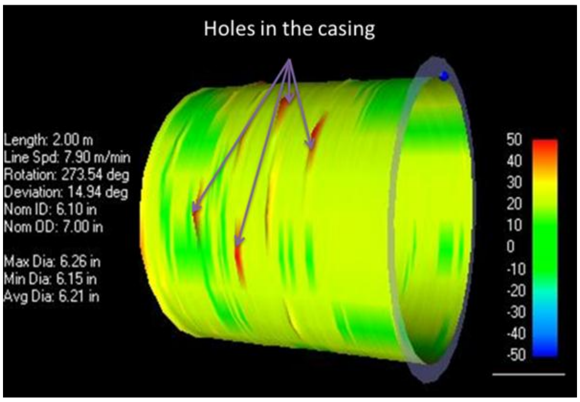

Figure II: Processed MIT Image of Well "A"

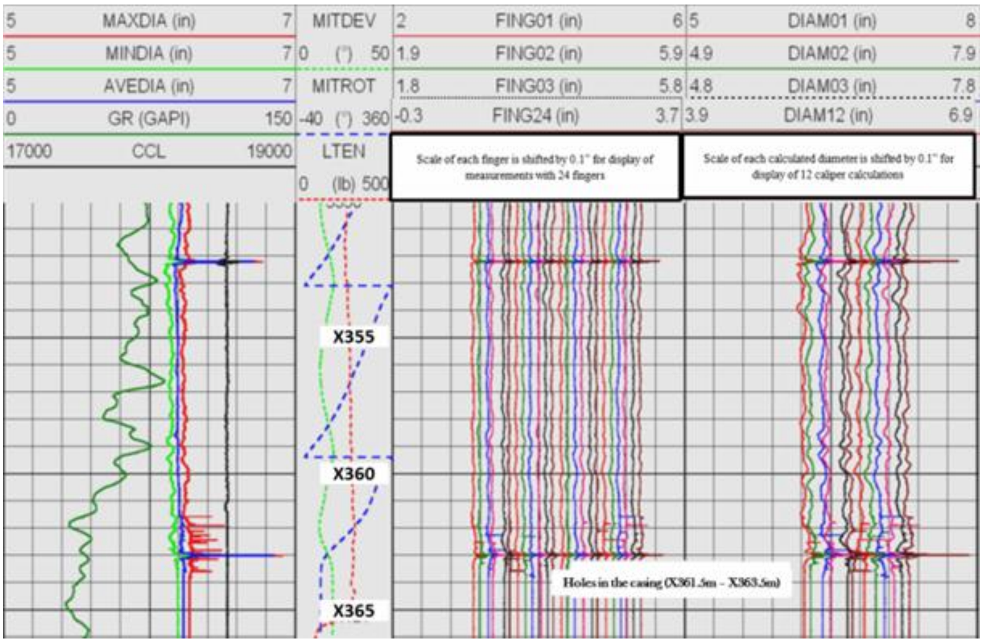

Figure III: MIT Logs of Well "A"

Well "B"

Well "B" was drilled in Feb. 2001 in Lakwa field and completed on hydraulic packer and GLVs with perforation interval X500.0 – X508.0m in TS-X. On activation,well came on self-flow with oil at 24 m3/d with 1.2% water cut.

During October 2003, WSO was planned in which cement squeeze job was carried out in the interval X500.0-X508.0m. Cement was drilled up to X505.0m. Interval X496.0– X502.0m was perforated and packer was set at X450.0m.

During April 2010, zone transfer from TS-2 to TS-3A was planned due to high water cut. Accordingly,cement squeeze job was carried out in TS-2 in the interval X496.0 X502.0m and TS-3A was perforated in the interval X682.0- X700.0m. Well was completed on GLVs keeping packer at X477.0m and shoe at X646.0m. On activation well produced 55m^3/d with 99% water cut. Multi-finger Casing Inspection log recorded on 15th April, 2010 indicated casing damage in the interval X500.0-X508.0m Figs. IV & V. The same interval was also squeezed in earlier work over job in October, 2003.Well on activation produced 55m^3/day with 99% water cut.

PLT was also carried out to locate the source of water. Well was found clear up to X743.0m with tubing shoe at X648.0m and top of packer at X648.0m.

It was concluded from PLT that perforated interval X682.0-X700.0m (TS-3A) was inactive and all the production was obseved from squeezed perforations X496.0-X508.0m (TS-2).

Thus PLT also confirmed findings of MIT i.e. leakage / casing damage in the interval X500-X508m.Subsequently, damaged casing interval X500-X508m was isolated by keeping permanent packer at X600.0m and hydraulic packer at X432.0m. On activation, the well produced, QL-52 m^3/d, W/C- 92%, Qo - 4 m^3/d.

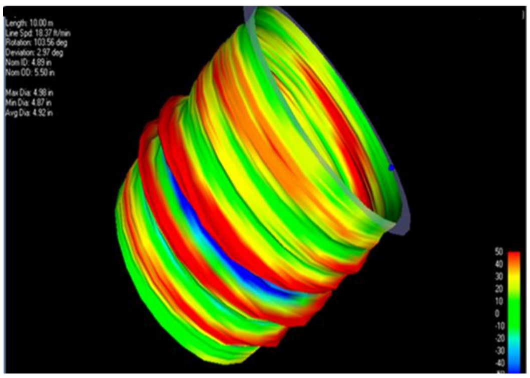

Figure IV: Processed MIT Image of Well "B"

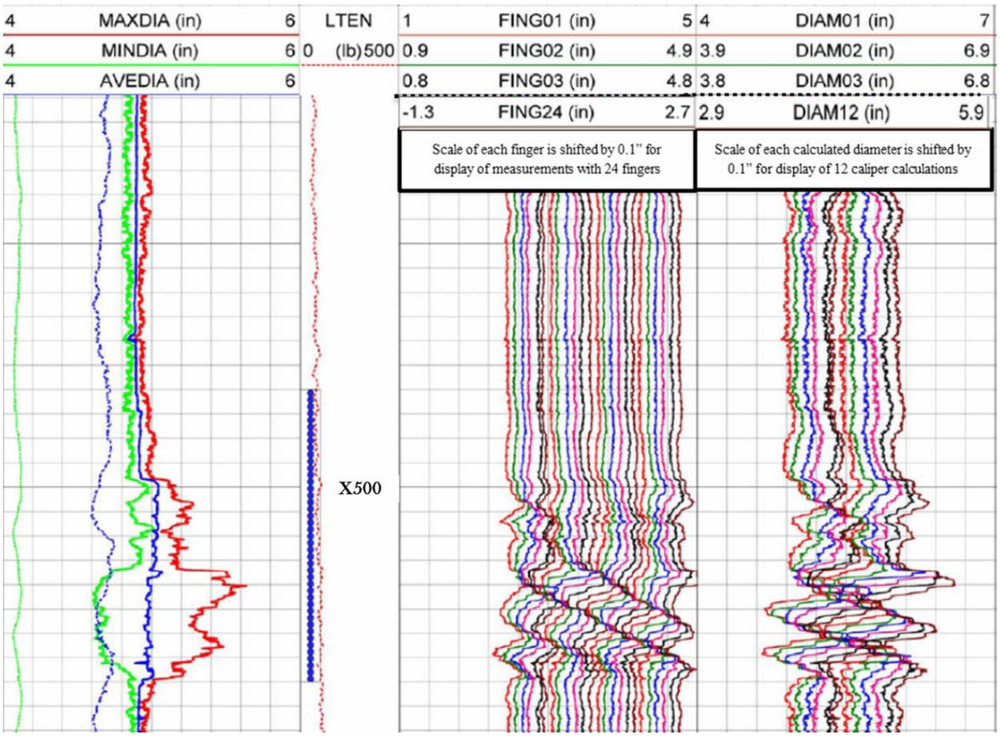

Figure V: MIT Logs of Well "B"

Well "C"

Well "C" was drilled in the year 1992 in Lakwa field and completed in TS-X sand (X492-X501m) on SRP,it initially flowed QL=18m^3/d with 80% w/c. The well was ceased due to SRP defect. During Ist Workover job (April-May, 1997) , SRP servicing jobs was carried out. As per test data in Nov,99, well was flowing with 31m^3/d with 96 % water cut. During IInd workover job (Feb-Mar-2001), CSQ was carried out in existing interval X492-X501m and further drilled upto X520m . Interval X493-99m was perforated and well was activated & completed on SRP. During IIIrd workover job, well was taken up for SRP servicing.

Well was in Non-Flowing status with High Water Cut in TS-X since 2002, it was planned to carry out IVth work over job for water shut off by polymer in TS-X sand Accordingly, well was subdued with KCl brine of specific gravity of 1.01. SRP and Tubings were pulled out completely. While running in POP and Tubings, held up was observed at the depth of X965.95m. The same was pulled out and running in with I/B (112mm dia) and tubings was carried out but held up was observed at the same depth. Suspecting any damage / problem in casing, MIT was carried out in the interval X850m – X200m. Based on MIT log, it was found that Casing Collar slipped from X944.73 – X945.1m Figs.VI & VII. Subsequently, it was decided to suspend further workover operations looking the severity of casing damage, which can not be repaired with the present available resources. Rig was released to next location without any further delay. Thus, MIT survey could provide clue about the extent of casing damage/abnormality thereby saving precious rig time.

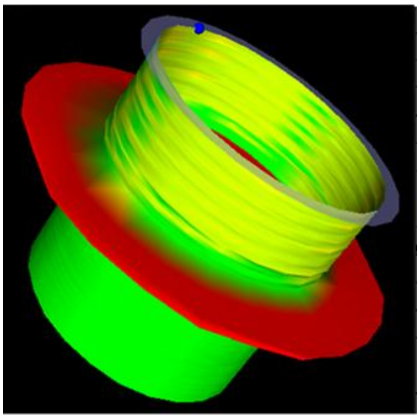

Figure VI: Processed MIT Image of Well "C"

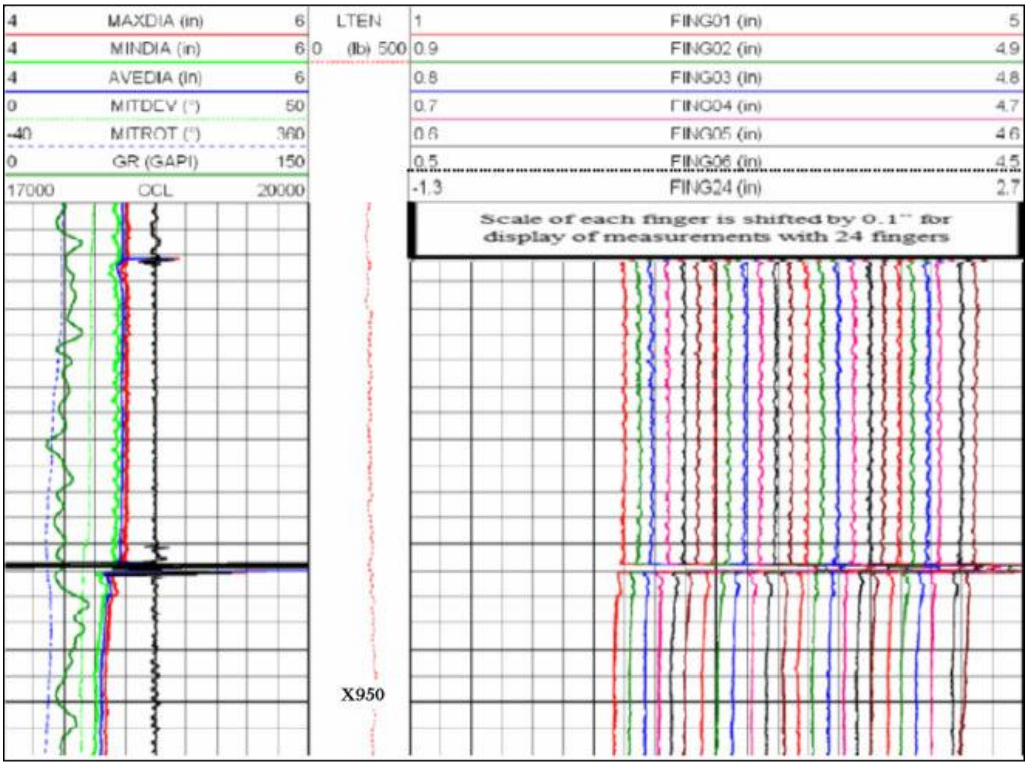

Figure VII: MIT Logs of Well "C"

Conclusions

Three case studies of Assam Asset where unplanned MIT logs were recorded during complications of work over job operations have been discussed in the present paper.

In two wells, based on the findings of recorded MIT logs, remedial measures were undertaken resulting in total oil gain of 8m3/day (4m3/day in each well). Whereas, in the third well , one casing collar was found slipped , thereby making further work over job not feasible. Subsequently, the rig was released for next location without wasting any more time.

Reference

WIVA v2.00 Well Integrity Visual Analysis Software, User Guide, Paul Shambrook, Ferry van der Vorst.

Acknowledgements

The authors are thankful to ONGC for permitting publication of the paper and Mr. B. K. Barua, ED-Asset Manager, Assam Asset for his guidance and constant encouragement. The views expressed in the paper are of authors only and not necessarily of ONGC.