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Production And Improvement Productivity Of An Oil Well By Water Restraining And Penetration Using PLT

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Abstract
As any operation that delays water to reach and enter the production wells. Water production is one of the major technical, environmental, and economic problems associated with oil and gas production. Water production not only limits the productive life of the oil and gas wells but also causes several problems including corrosion of tubular, fines migration, and hydrostatic loading. The conventional water shutoff method has been applied in Sharara field for the wellbore isolation by cement plug in the watered out zone, fortunately it was successful. In this project as PLT calculation was done by using water hold-up sensor as following: shut – in the well and run PLT Log was correlated for depth matching of well X 1 to 5250 ft end of last perforation, then full-bore Spinner passes were consistent and repeated and did not show any cross flow between perforations The Changes in spinner rotation at few intervals is corresponding to change in caliper readings. Flowing the well Full-bore Spinner passes were consistent and repeated, Passes also indicated the inflow zones, was consistent and repeated and illustrated the fluid distribution in the wellbore, show that the main hydrocarbon bubble entry at the wellbore filled with water. Final result showing that for A-06 well first and last perforation (4810 ft – 4840 ft) & (4852 ft 4916 ft) producing water with (5.17) % & (87.72) % WC.
Keywords: *Water breakthrough; PLT, Water shutoff WSO, Workover, perforation, Bridge plug.*

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I. Introduction

Production Logging Tool (PLT) refers to any device utilised for the purpose of generating production logs. These tools are inserted into fully developed and operational wells. These technologies facilitate the analysis of the dynamic performance of a well and also enable the determination of the individual contribution of each zone (in the case of co-mingled stacked sands or similar zones) to the overall production or injection. They additionally facilitate the allocation of hydrocarbon output on a zone-by-zone basis.Examination of the production logs can be used to identify any issues, such as leaks or cross flows, in the oil or gas producing wells [1]. Production logging tools (PLT) are used to descend the wellbore and document the characteristics and properties of fluids within the well during any production or injection activities.The employed production logging tools are modular and may be integrated with a variety of sensors to record production data. The technologies offer instantaneous production data and produce logs at regular intervals. Throughout the manufacturing process. The primary objective of production logging tools is to examine and assess the performance of a borehole, such as the dynamic or static state of a production well. These tools also measure the productivity and injectivity index of zones or layers within a field, investigate borehole inefficiencies by interpreting collected logs, evaluate the effectiveness of stimulation or completion procedures, and determine the physical condition of a well.Production logging tools have several primary applications, including identifying well mechanical issues, evaluating the effectiveness of completion processes, observing and monitoring production and injection profiles, obtaining reservoir characteristics, and detecting cemented channels. Reference 2. Production or injection profiling involves the use of a diverse array of production logging technologies to analyse various downhole settings in vertical, deviated, and horizontal wells. Modular and combinable with Array Production Logging sensors, Standard Production Logging equipment offer precise measurements of flow velocity and gas hold.

Full bore Spinner **Basket flow meter** **continuous spinner flow meter** **Inline flow meter** **Diverter**

Figure 1: types of PLT, Hobar

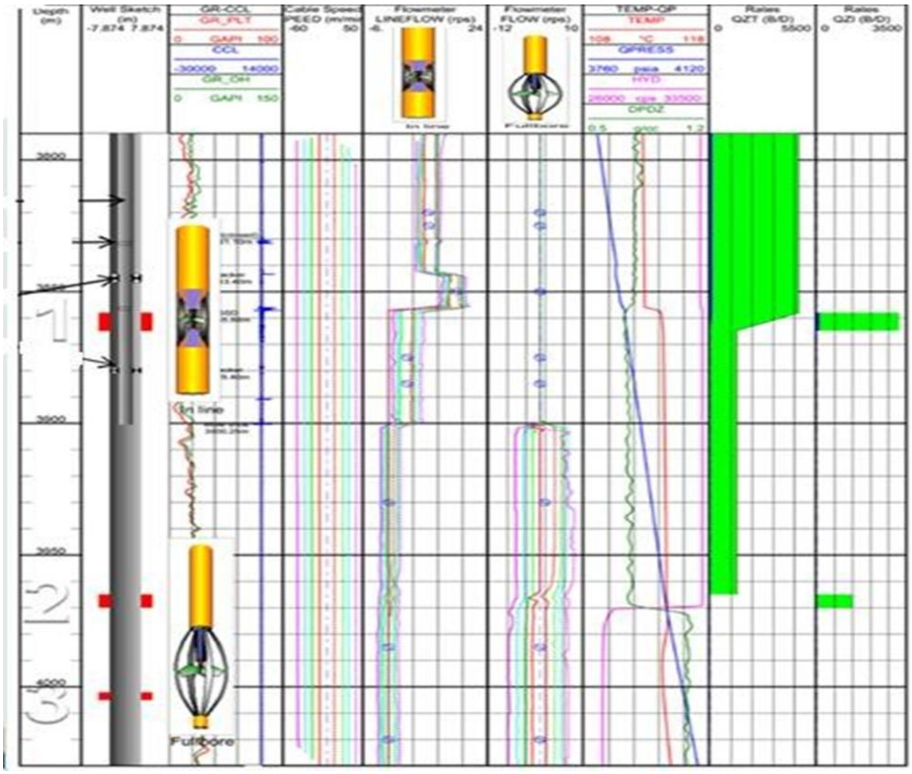


Figure2: overview of PLT main data, Geophysical Well Logging. [4].

II. Data, Tools, And Results

PLT Tools

Production logging tools are one of the leading operating services especially for cased- hole drilling, which entails monitoring the cement displacement, pipeline corrosion, and contacts. Moreover, it has been utilized in the setting of the packers, plug equipment, and perforation procedures. The most exceptional appeal of using production logging tools is to diagnose the problems which are caused by production operations such as leakage and occurring cross flow through the wellbore [5]. There are many ways and techniques to obtain the measurement of the formation's fluid viscosity; however, it could be estimated by spinner flow meter (a rotational blade which will turn when the reservoir fluid moves through the edges and past it). In ideal conditions, the rotational speed of the blade in revolutions per second (RPS) is proportional to the fluid velocity.[6]. Friction in the spinner bearings and effects from fluid viscosity result in nonlinear velocity responses, requiring calibration of the measurement. This calibration is accomplished by making upward and downward passes at varying logging speeds. Before absolute fluid velocity is computed, spinner speed is corrected for relative tool speed. Because of friction near the pipe wall, absolute fluid velocity is not the same as the average velocity of fluid moving through the pipe. After applying correction factors, engineers convert the spinner velocity to an average velocity using computer modeling techniques, which present the fluid velocity profile across the pipe diameter. [7]. Production logging tools provide high resolution measurements of the fluid identifications and flow rates in the downhole well environment that are used to evaluate well performance. A typical production logging tool string consists of multiple sensors covering a range of physical measurements in order to identify fluid types, volumes and rates of their production or injection profile. The combination of sensors and their configuration may be tailored to suit producing or injecting wells and to resolve single-phase, two-phase or three-phase flow regimes. Tools come in a range of sizes to provide optimal coverage and resolution across a range of tubular diameters. [8]. Once the logs are prepared, dynamic analysis of well performance is done at different production zones. The logs are also used to monitor the results when well stimulation is performed. Production Logs are produced for all types of wells (vertical, deviated or horizontal). The production logging tools used are modular and can be combined with array of sensors that logs the production data. [8].

These tools provide real-time production data and generate logs at continuous intervals during the production. Standard Tools 1. Wireline Telemetry Sub (WTS) 2. Gamma Ray Tool (GRT) 3. Quartz Pressure/ CCL (PCT) 4. Fluid Density Tool (FDT) 5. Capacitance/Temp/Flow (HTF) 6. Folding Flowmeter (FFM) or 7. Continuous Flowmeter Jewel (CFJ) 8. Roller Centralizer Tool (RCT). Auxiliary Tools 1. Knuckle Joint Tool (KJT) 2. Downhole Tension Tool (DTT)3. Downhole Swivel Sub (SVL). Production logging consists of running logging tools in [9].

both production and injection wells. They can be run under dynamic (flowing) or static (shut in) conditions. With proper interpretation, production type, production intervals, and flow rates can be determined. Production logging can be identified: 1. Water entry/exit locations and sources 2. non-performing perforations 3. Flow behind casing or tubing 4. Crossflow 5. Leaks in tubing or casing 6. Unproductive/receptive intervals for stimulation 7. Packer leaks 8. Lost-circulation zones. [10].

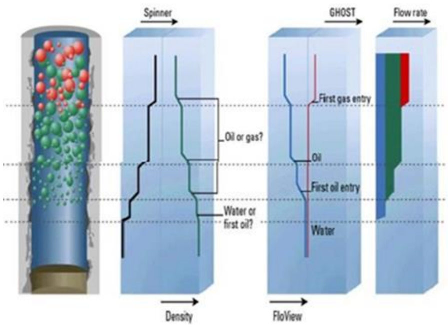


Figure3: downhole flow velocity. Chiedu L. Ezenweichu1., Oluwapelumi D. Laditan. (2015). [6]

Data and Results

Well X is located in field Y. It is a vertical well. The well type is producer and the completion type is intermediate casing 9 5/8”. And Perforation intervals 4660-4770 ft & 4732-4790 ft & 4810-4900 ft. The fluid production per day reaches a cumulative rate of 5280 bpd and WC ~ 87.7%

Workover Objectives:

Isolate the lower perforated zone to reduce the water production (down 4810 ft. Kb), also it’s recommended to keep the inflow zone between (4798 to 4810 ft. Kb open) this zone shows no contribution from PLT, but after implement the WSO the contribution in this zone might be improved,

Workover Procedures:

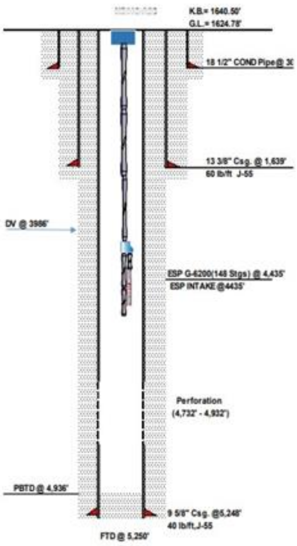
1) Rig move & rig up on well X. 2) Bleed off any pressure on Tbg & casing. Notes: Report the pressure in DWR. 3) R/U ALGAR Slick line unit & retrieve the blanking plug. 4) Kill the well by pumping brine fluid down tubing & annulus, if required. 5) N/D X-mass tree, N/U hydrilla and P/T to1500psi. 6) Unset and pull up Tbg Hanger. 7) POOH existing ESP assembly (3 X G6200 (2 x 54 + 40) 148 Stgs , 208 HP Motor + Y-tool with check valve) on 3 ½” tbg. 8) M/U, RIH with 8 ½’’ bit & 9 5/8’’ casing scraper on 3 ½’’ tbg to top of perforation @ +/- 4,700’. 9) POOH 8 ½” bit & 9 5/8” casing scraper.

Shut Off Procedure:
1. Rig up wire line equipment, EHST (Electro-Hydraulic Setting Tool) with bridge plug to avoid plug stuck while RIH.
2.Pressure Test WHE to 1.2 x expected WHP
3. RIH with CCL, EHST and bridge plug. Estimated Setting depth @ 4810 ft). 4. Make correlation pass and confirm depths. 5. Setting bridge plug 7 feet below shut off depth (Estimated Setting depth @ 4817 ft). 6. POOH with CCL and EHST string. To get 2000 psi differential pressure in 9 5/8'' casing we must fill 7 feet cement above the plug. To fill 7 feet cement in 9 5/8'' casing We need to do 2 runs with 4'' dump bailer (Every run with 20 feet dump bailer length). 7. RIH with first dump bailer run. 8. Stop above the plug and dump the cement. 9. POOH with dump bailer string. 10. Perform the second dump bailer run. 11. POOH with dump bailer string. 12. RIH with dummy run to tag on the top of cement. 13. Confirm depth, Tag new PBTD, has to be about 4810 ft.Kb (if the tag below shut off depth, will perform another dump bailer run). 14. POOH with dummy string.

ESP Replacement

1.M/U and RIH new ESP, (1 X SN2600 86 Stgs , 104 HP Motor + TRI-SENSOR with check valve) on new 3 ½" tbg. 2. Connect Motor flat cable Extension and RIH ESP assembly on 3 ½" tbg, check conductivity every 500 ft and band cable every 10ft. 3. Cut and Splice Reda cable, M/U tubing hanger, connect lower pigtail and land tubing hanger on tubing head spool with intake depth 4400 ft. Note: Report the final setting ESP depth on DWR. 4. R/D equipment and Rig floor. 5. N/D hydrilla, N/U X-mass tree and P/T to 2000 psi-ok. 6. Connect Surface electrical cable to junction box, start-up pump and check rotation ok. 7. Put well on testing. Note: Final decision for the permeant pump in hole will be done based on well testing results.

Attachments for well x



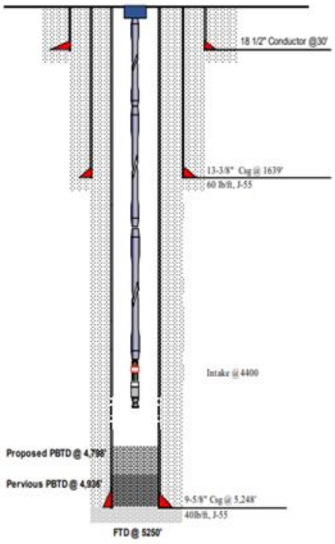


Figure4a: Attachments for well x
Figure4b: Attachments for well x

Testing Procedure:

1. Put well on production lined up with separator test (set VSD at 45 hz). 2. Keep well on production for checking rotation and cleaning up period for about 12 hrs. 3. Collect well Bsw samples from well head and manifold every 4 hrs. 4. When BSW stabilize, DFL measurement every 4 hrs with WHP and Csg pressures. Report the results on daily bases. 5. Report the production rates from the separator test for the 4 main flow period at 45,50 and 55 and 60 hz, each period for 6 hrs minimum. Expected rate at 60 hz is 2950 bfpd. 6. Final decision will be given based on the received production test results. 7. Shut-in the well and collect fluid level after 24 hrs.

III. PLT Results Interpretations:

Down hole Flow Rate Results (Well Flowing)

The estimated total water and oil production are 4098 bbl/d and 911 bbl/d, respectively, at down hole conditions. Significant water production (majority) is coming from the bottom perforation, (represents ~ 88% of the total water production). It is very clear that this water contribution is choking oil entries from production.

Therefore, this well is very good candidate for water shut-off, by isolating the bottom perforation (4810 – 4900) ft. Low contribution from the upper part of the bottom perforation. However, hold up measurements RAT and CWH indicated some oil produced from this part (not quantified). The total oil production is produced by the bottom part of the top perforation; however, the upper part of this perforation is in shale zone. Table1: Down hole Flow Rate Results (Well Flowing)

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erforation ft		Inflow zones ft		Zonal Oil Rate bbl/d	Oil Contribution %	Zonal Water Rate bbl/d	Water Contribution %
4660	4770	4732	4770	535	58.73	0	0.00
4732	4790	4770	4798	376	41.2	291	7.10
4810	4900	4810	4840	0	0.00	212	5.17
		4852	4916	0	0.00	3595	87.73
Total				911	100	4098	100

Surface Flow Rate Results (Well Flowing)

The estimated total water and oil production are 3967 STB/d and ~827 STB/d, respectively, at surface conditions. The accuracy of the estimated surface rates depends on the accuracy of the provided PVT data. - As reported from the field, the well was fully open (100%), and WHP ~ 200 psi. Table2: Surface Flow Rate Results (Well Flowing),

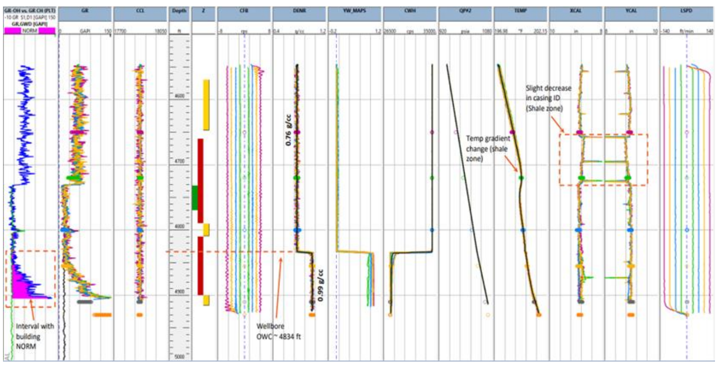
Table2: Surface Flow Rate Results (Well Flowing)

Perforation ft		Inflow zones ft		Zonal Oil Rate bbl/d	Oil Contribution %	Zonal Water Rate bbl/d	Water Contribution %
4660	4770	4732	4770	486	58.73	0	0.00
4732	4790	4770	4798	341	41.23	282	7.11
4810	4900	4810	4840	0	0.00	205	5.17
		4852	4916	0	0.00	3595	87.73
Total				827	100	4098	100

PLT Raw Data (Shut-in Survey)

This plot represents the PLT raw data that was acquired in shut-in conditions. Four down and four up passes were recorded. All the PLT sensors worked fine and repeat well.

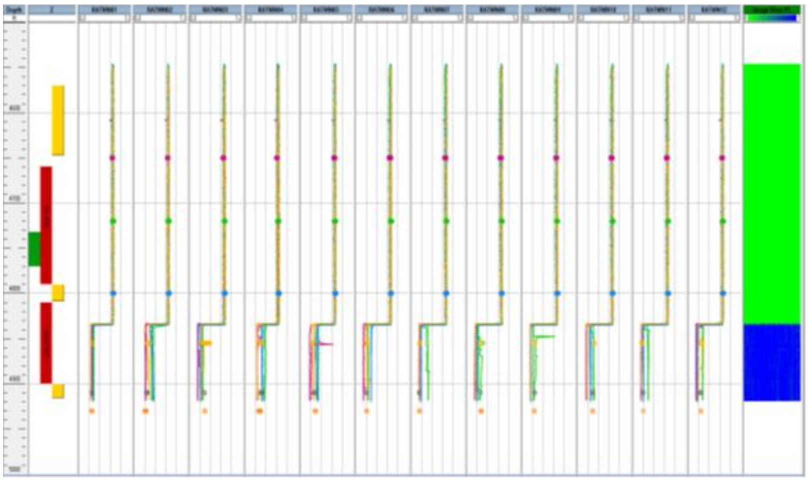
- YW_MAPS is the measured water holdup by the 12 RAT probes. The water holdup from the all passes is presented here, it shows wellbore OWC ~ 4834 ft, which seen by other measurement (Density and capacitance). The fullbore spinner response passes and stations indicate no flowing dynamic during shut-in the well, and the well was completely static. Pressure and temp indicated very good well stability. Slight change in casing ID (possible scale due to shale zone) at the perforated section in shale zone (4660 – 4730) ft. see of figuer6: PLT Raw Data (Shut-in Survey)



Figuer6: PLT Raw Data (Shut-in Survey)

Resistivity Array (RAT) Raw Data (Well Shut-in)

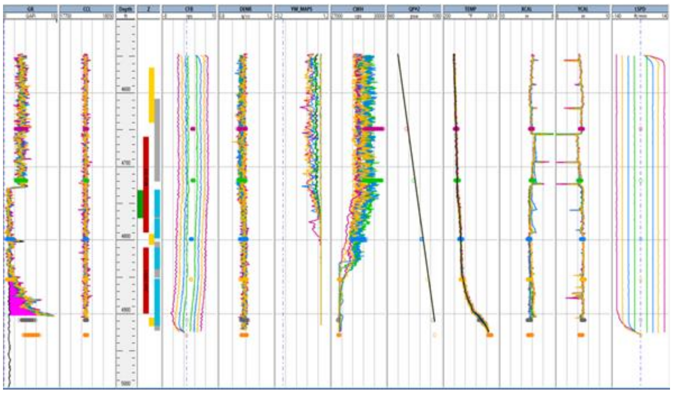
This plot represents the Resistivity Array (RAT) raw data. The 12 probes worked fine and indicated wellbore OWC ~ 4834 ft due to good fluid segregation. - The image on the first track from the right hand side represents the combined holdup image (scale is 0 to 1), green is HC and blue is water. - At the stagnant water, the repeatability was not that good, this might be due to probe's wettability issue (Both up and down passes were considered in calculating water holdup in the interpretation). Figuer7: Resistivity Array (RAT) Raw Data (Well Shut-in)



Figuer7: Resistivity Array (RAT) Raw Data (Well Shut-in)

PLT Raw Data (Well Flowing)

This plot represents the PLT raw data that was acquired in flowing conditions. Four down and four up passes were recorded across the perforated interval. - YW_MAPS is the measured water holdup by the RAT resistivity probes. The water holdup from all the passes is presented here. – The full bore spinner worked fine and indicates that most



Figuer8: PLT Raw Data (Well Flowing)

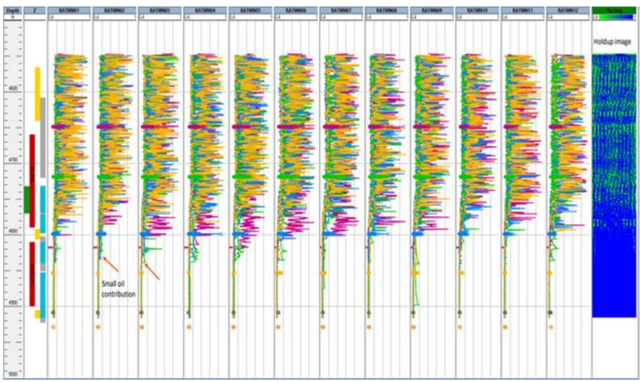


Figure 9: Resistivity Array (RAT) Raw Data (Well Flowing)

PLT Raw Data (Well Flowing)

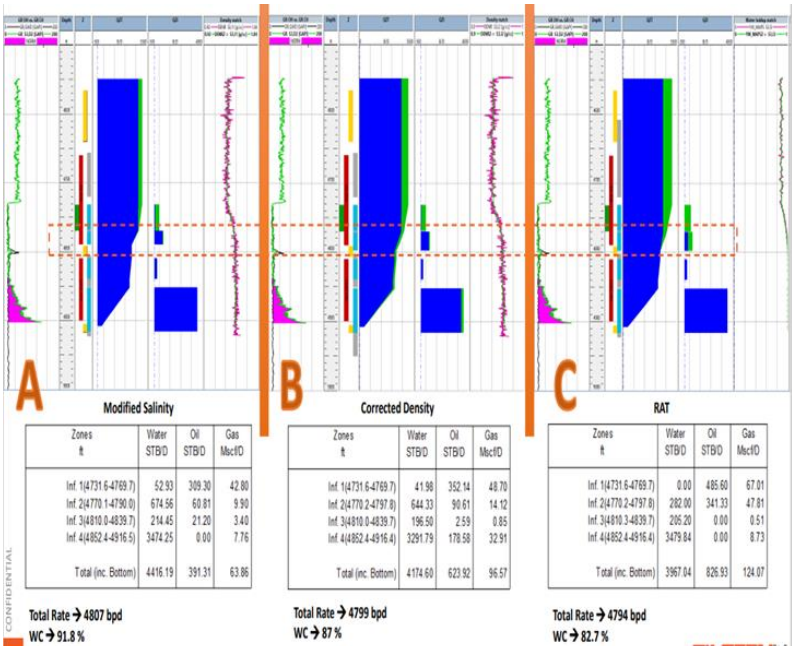
This plot represents the PLT raw data that was acquired in flowing conditions. Four down and four up passes were recorded across the perforated interval. - YW_MAPS is the measured water holdup by the RAT resistivity probes. The water holdup from all the passes is presented here. – The full bore spinner worked fine and indicates that most of the production is coming from the bottom perforation. However, all perforations are contributing except to the top part of the upper perf that is perforated in shale zone. Both RAT and Capacitance indicated some HC flowing from the top part of the bottom perf. - The X-Y caliper worked fine and repeat well with shut-in data. Spinner data indicated to contribution from non-reported perforations: - Below the top perforation → flow started ~ 4798 ft (while bottom perf reported 4790 ft). - Below the bottom perforation → flow started ~ 4916 ft (while bottom perf reported 4900 ft), and this is confirmed by the spinner station acquired 4910 ft, where the spinner was rotating. - The upper part of the top perforation (4660 - 4731) ft is in shale zone. Figuer8: PLT Raw Data (Well Flowing)

Resistivity Array (RAT) Raw Data (Well Flowing)

This plot represents the Resistivity Array (RAT) raw data. The 12 probes worked fine and indicated significant change in hold up between up and down passes; during up passes the oil is dominating the wellbore, while more water is observed while logging down. This might be due to probe's wettability issue. Both up and down passes were considered in calculating water holdup in the interpretation. The image on the first track from the right hand side represents the combined holdup image (scale is 0.8 to 1), green is oil and blue is water. -The probes indicate the presence of oil bubbles across the bottom part of the top perforation. Figure 9: Resistivity Array (RAT) Raw Data (Well Flowing)

Holdup measurement and Flow Profile Comparison

This flow profile was based on density data as holdup measurement, and to match the density log at the water zone, a water salinity of 30,000 ppm was considered, the reason is, density read ~ 0.99 g/cc at the water zone, while the water salinity from this well ~ 1190 ppm (equivalent density ~ 0.96 g/cc).- This flow profile was based on density data as holdup measurement, and to match the density log at the water zone, density was corrected by deduction of 0.03 g/cc), and true water salinity was used in this scenario (1190 ppm). This flow profile was based on RAT data as holdup measurement, and density was excluded. Figuer10: Holdup measurement and Flow Profile Comparison



Figuer10: Holdup measurement and Flow Profile Comparison

IV. Conclusion

well x the total Production rate was 5280 bpd with 87.7% of WC. Main production interval are 4660-4900 ft with high production value. According to the water hold-up data water is being produced from the intervals 4810-4840 ft & 4852- 4961ft bottom preformation intervals. and The reason for producing water in well x1is the presence of injection wells close to it (x2-I and x2-I). If production tests at any well showing increase of water value, run PLT log to determine the OWC and water zone and PLT must run in two cases (well shut in & well flowing) to get accurate results fromtest and the job of water shut off will successful 100%. In well x the Total depth is 5250 ft and the bridge plug At 4798 ft Then they made a Re-perforation at a depth 4735-4770 ft. The pressure and temperature at mid of preface should be recording under shut in(long term), low production and high production.

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