



Optimization of Auto Gas Lift (AGL) and revival of sick well based on Production Logging Results: A case study from Western Offshore

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Keywords

Auto Gas lift, Sick well, Production Logging, Crossflow, Recirculation, Zone-wise Production Profiling, Intervention, Oil gain

Abstract

An auto gas lift (AGL) serves the same function like any other Gas lift Mandrel (GLV). In Auto gas-lifted wells, gas from either a gas zone or gas cap is used for lifting liquid hydrocarbon from wells having an oil zone below using commingled completion. The gas energy which is being produced from the same well is often used to lift the liquid hydrocarbon from below and maximise the production without having to inject gas from surface. The above can be suitably modified if we ascertain the zonal contributions in the well through Production Logging. Knowing the zonal contributions, the orifice of AGL can be optimised in such a way so as to maximise the liquid hydrocarbon lifting. In the present paper, the well was completed in Lower B formation for oil exploitation with a provision for Auto gas lift utilizing gas from Upper B formation. Production Logging (PL) was done in this well and zone-wise contribution was mapped and recirculation of water and hydrocarbon observed. Optimization of Auto Gas Lift (AGL) was done based on PL results and oil gain of 417 bopd was achieved in the well. Before PL, the well was flowing with 95% w/c and after optimization of AGL, it started flowing with oil rate almost similar to initial production rate and with reduced water cut in comparison to initial w/c.

Introduction

Production Logging (PL) is an important diagnostic tool for evaluating the reservoir dynamics and diagnosing well integrity issues like packer, tubing leaks, casing damage etc. It is imperative that the problem be diagnosed early for keeping the well healthy for a sustained production. A base line PL in a well immediately after it has been put on production is increasingly gaining importance to

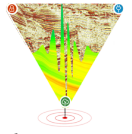
know its early behaviour down-hole. Time lapse surveys over a period of time helps to ascertain the change in reservoir dynamics with reference to the base PL. Production Logging is an important diagnostic tool not only for knowing the zonal contributions but also to detect cross flow between layers or recirculation in the well. In the present case study, cross-flow of gas was observed between layers in shut-in PL surveys and, recirculation of water and hydrocarbon is observed in flowing PL surveys. Zone-wise production profiling was carried out and further to arrest recirculation, optimization of AGL was done.

Auto gas lift (AGL)

Auto gas lift is a natural or in situ gas lift system which utilizes downhole reservoir gas caps or non-contiguous gas-bearing formations for lifting oil to the surface (Figure-1). There are multiple opening positions like fully open, fully closed, and upto six intermediate choking positions. These are surface operated valves for changing the positions and capable to operate under high differential pressures. AGL is compatible with both oil and water based Completion fluids.

Case Study (Well ABC-3)

ABC is a Marginal field discovered in the year 1991 in Western Offshore of India. It is a NW-SE trending, elongated fault closure, bounded by a prominent fault on the eastern side and characterized by series of structural culminations. The well ABC-3 was drilled as an inclined well (Maximum deviation: 37 deg) in the year 2019 to exploit oil from Lower B formation. Based on log characteristics, upper B formation is gas bearing and lower B formation is oil bearing. No gas injection lines were available on the platform. So, the



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well was completed in Lower B formation for oil exploitation with Auto Gas Lift (AGL) from Upper B formation.

Well Schematic and well history

The well is completed in 7” liner and 3 ½” tubing with perforation interval in lower B (xz74-xz87m) in casing and upper B (xx96-xy00m) in tubing via AGL at xa51.9m (Figure-1). Initially in year 2020, the well was producing liquid @844 blpd, oil @464 bopd with w/c of 45%. Before Production Logging (Year 2021), the well was producing 245 blpd liquid with w/c of 95%. Seeing the decline in oil rates and increase in w/c, PL was planned in this well to do the production profiling and to know the root cause behind rapid production decline. After one year, rapid decline in oil rate and increase in w/c was observed). For 5 months before PL, average oil production rates were ~ 10 BOPD with >90% water cut (Figure-2).

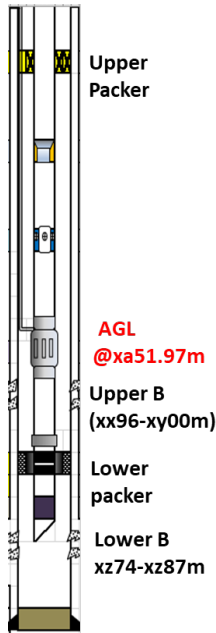


Figure-1: Well Schematic

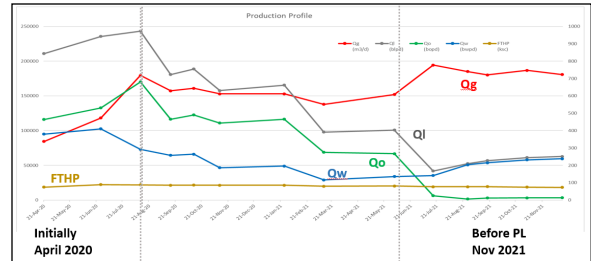


Figure-2: Production history of well from initial production to production before PL.

Production Logging (PL)

The well was producing oil @13 bopd and water @231 bwpd, w/c ~95% and gas @1,86,799m³/day at the time of PL. FloScan Imager (FSI) tool consisting of Flowmeter, Pressure, Temperature, DEFT (water hold up), GHOST (gas hold up) and Fluid Density were lowered. Shutin and Flowing PL surveys were recorded in both tubing and casing.

Shutin PL Survey

In PL, during shut-in survey, downward crossflow of gas was observed from the Upper B Perforation (xx96m - xy00m) via AGL (xa51.9 m) to the Lower B perforation (xz74m - xz87m) as can be seen in mini spinners (Figure-3). From rates computed from PL, crossflow of gas@17,794 m³/day is seen from upper B to lower B open interval (Table-1).

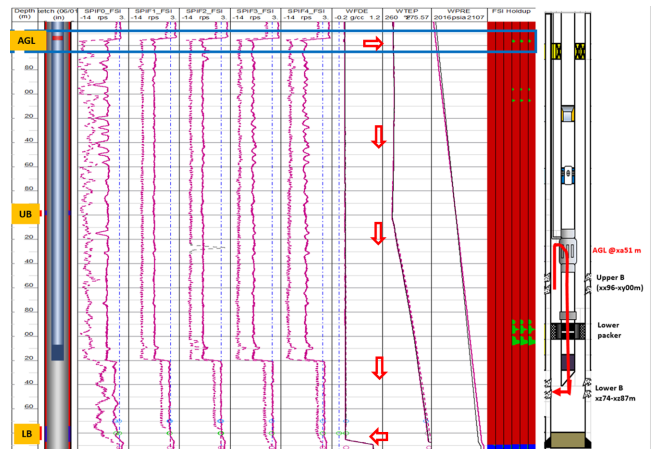
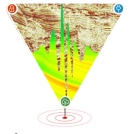


Figure 3: Shutin PL Survey- In shut-in passes, downward crossflow of gas is observed from the Upper B (xx96m - xy00m) via AGL (xa51.9 m) to the Lower B (xz74m - xz87m).



Optimization of Auto Gas Lift (AGL) and revival of sick well based on Production Logging Results: A case study from Western Offshore Basin

Table 1: Calculated PL Surface Results (FSI Shut-In Crossflow)

Pay	Open Interval (m)	Water bwpd	Oil bopd	Gas (m3/day)
AGL @xa51.97 m (Upper B)		-	-	17,794
Lower B	xz74-xz87m	-	-	-17,794

Flowing PL Survey (Tubing)

In flowing survey recorded in tubing, top perforation xx96m - xy00m (Upper B) is contributing to majority of gas which is being produced via AGL at xa51.97m as observed on spinner, holdup and temperature data. Figure-4 shows flowing PL survey against AGL in tubing indicating flow of gas from upper B (Figure-4). Figure-5 shows the response of all the sensors at a particular depth above AGL showing majorly gas production.

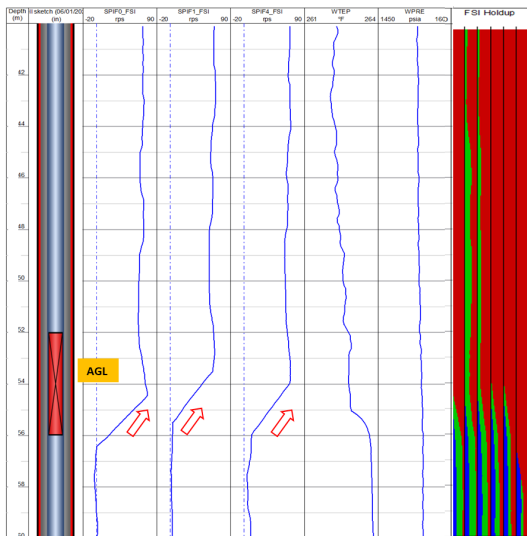


Figure-4: Flowing Survey in tubing (via AGL) showing majorly gas production from upper B perforation interval (xx96m - xy00m).

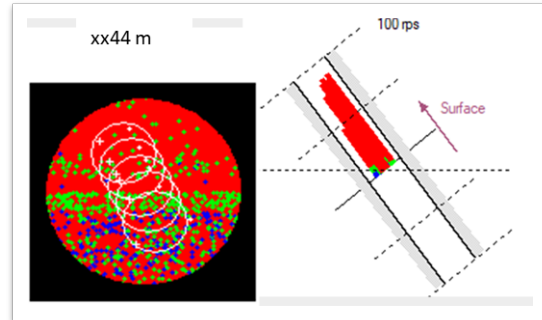


Figure-5: Flowing survey at a particular depth in tubing showing hold up and spinner data.

Flowing PL Survey (Casing)

In flowing survey recorded in casing, major water production is observed from the bottom perforation xz74m - xz87m (Lower B) as seen on spinner and holdup data. Recirculation of water and hydrocarbon is observed on the bottom spinners across the logging interval (Figure-6). Figure-7 shows the response of all the sensors at a particular depth above perforation interval xz74m - xz87m (Lower B), which is showing majority of water production along with some hydrocarbon.

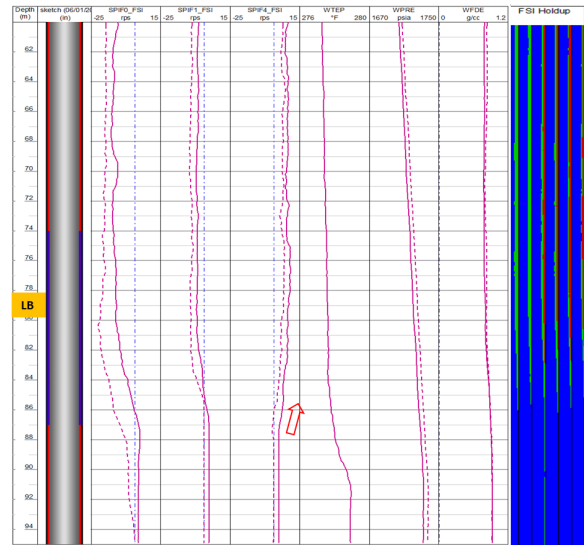


Figure-6: Flowing Survey in casing: Major water production observed from the bottom perforation xz74m - xz87m (Lower B) as seen on spinner and holdup data.

Optimization of Auto Gas Lift (AGL) and revival of sick well based on Production Logging Results: A case study from Western Offshore Basin

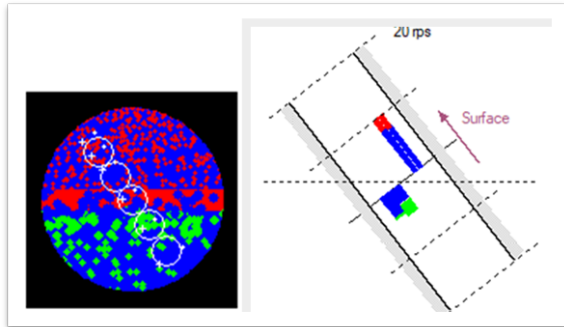


Figure-7: Flowing survey at a particular depth in casing showing hold up and spinner data.

Production Profiling

Zone wise contribution from PL was carried out and surface flow rates were calculated (Figure-8 & Table-2). Top perforation interval xx96m - xy00m (Upper B) via AGL is contributing gas@151000 m3/day. The bottom perforation interval xz74m - xz87m (Lower B) interval is contributing Water@327 bwpd, oil@60 bopd and Gas@27,533 m3/day.

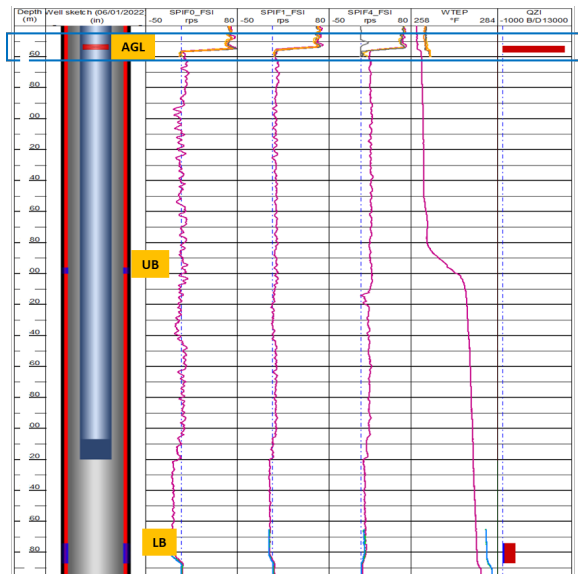


Figure-8: Production profiling in both tubing and casing through PL

Table 2 : Calculated PL Surface Rates (Flowing Survey)

Pay	Open Interval (m)	Water bwpd	Oil bopd	Gas (m3/day)
AGL @xa51.97 m (Upper B)		Traces	Traces	151000
Lower B	xz74-xz87m	327	60	27533
Total		327	60	178533

Optimization of AGL after PL

To arrest recirculation, optimization of gas lift was carried out based on PL results. Auto gas lift (AGL) orifice changed from 0.44 to 0.22 which resulted in oil gain of 417 bopd and revived a sick well. Before PL, the well was flowing 245 blpd liquid with ~95% w/c. After intervention, oil rate of 430 bopd (which is similar to initial oil rates) with 32% w/c was achieved which is even less w/c than initial w/c (Figure-9).

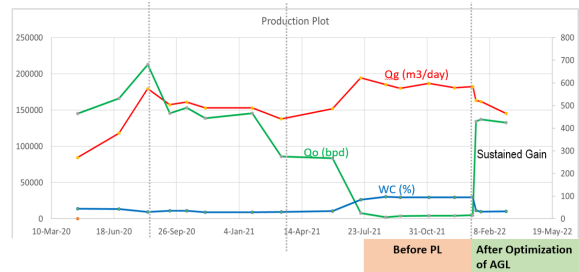
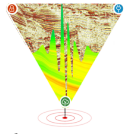


Figure-9: Production of well before and after AGL optimization

Conclusion

In the above case study, zone-wise contribution from each layer was done through Production Logging. In shut-in survey, downward crossflow of gas is observed from the Upper B Perforation (xx96m - xy00m) via AGL (xa51.9 m) to the Lower B Perforation (xz74m - xz87m). In flowing survey, majority of water with some hydrocarbon is seen from the bottom layer (Lower B). Majority of gas contribution is from upper B interval and this gas is being produced via AGL at xa51.9m. Recirculation of water and hydrocarbon is observed in flowing



Optimization of Auto Gas Lift (AGL) and revival of sick well based on Production Logging Results: A case study from Western Offshore Basin

survey. Optimization of Auto Gas Lift (AGL) was done based on PL results and oil gain of 417 bopd was achieved in the well and restored its initial oil production rates and revived a sick well.

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