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Gas Lift Optimization of CAT-07H Well in Cath Offshore Field Using Gas Lift Pack Off

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Abstract. Well CAT-07H is a producing oil well located in Cath Offshore Field. This well has been producing using gas lift method which its injection gas is supplied by COM-182 compressor. In June 2019, the production of this well was interrupted by the fault of COM-182 which initially supplied 1100-1300 psi injection pressure at CAT-07H casing to only 800-1000 psi after being repaired. Due this change of injection parameter, CAT-07H was no longer able to be produced due to insufficient injection pressure. In the other hand, the well having relatively high water cut (75%) and depleted reservoir pressure made this well can no longer flowing naturally. The most possible solution for this problem is to optimize gas lift injection depth to match the new supplied gas pressure. In this paper CAT-07H is the sample well candidate to be evaluated for GLPO installation. CAT-07H is initially a gas lifted well which receive gas from COM-182 compressor. Due to decrease in performance of COM-182 compressor, gas parameter received on CAT-07H from COM 182 is no longer suitable with existing gas lift installation. Based on evaluation, gas pressure generated from this compressor decreases from 1100-1300 psi range to 800-1000 psi range. Based on this data, gas lift optimization is required to adjust gas lift on CAT-07H to meet the new pressure range. 800 psi is used as design parameter with maximum injection gas rate of 1 MMSCFD. Based on the evaluation in this thesis, it is found that gas lift can be optimized using GLPO method by changing the injection point to 2900 ft with punch port diameter if 0.15 inch which can be acieved using 1606 L puncher. After the optimization using GLPO on CAT-07H, production rate can be optimized to 2532 BFPD with net production of 633 BOPD.

Keywords: *gas lift optimization, GLPO, retrofit gas lift*

INTRODUCTION

CAT-07H is an offshore oil well located on CATH Platform, Cath Offshore Field operated by PT Pertamina EP. Most of producing oil wells in this field are naturally flown or gas lifted. CAT-07H is one of gas lifted well in Cath Offshore Field [1]. The primary problems of gas lifted well in Cath Field was the lack of gas lift optimization with changes on reservoir parameter and also unstable gas pressure supplied by existing aging compressor. In June 2019, the production of this well was interrupted by the fault of COM-182 which initially supplied 1100 [2]-
1300 psi injection pressure at CAT-07H casing to only 800-1000 psi after being repaired. Due this changes of injection parameter, CAT-07H was no longer able to be produced due to insufficient injection pressure. In the other hand, the well having relatively high water cut (75%) and depleted reservoir pressure made this well can no longer flowing naturally [3-5]. Roughing was attem1pted to this well in other to start up CAT-07H with existing parameter but this attempt was unsuccessful. Therefore, it is necessary find most the most optimum solution to bring back CAT-07H back in production with its maximum potency possible with available gas lift parameters. Figure 1 shows the original well diagram of CAT-07H [8-10].

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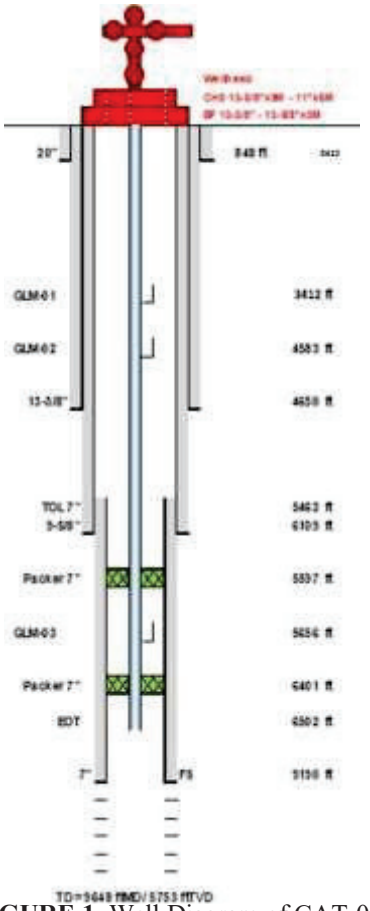

FIGURE 1. Well Diagram of CAT-07H

Evaluation of Gas Lift Injection Depth with Existing Gas Supply Parameter

The one of production problem of well CAT-07 H is the changes in reservoir parameter (reservoir pressure and water cut) and gas lift gas supply parameter due to the declining performance of compressor COM-182. Initially COM-182 was able to supply gas lift gas at pressure reaching well head of CAT-07H of 1100-1300 psi. However, after the decline of performance of this compressor, gas pressure received at well CAT-07H is now only ranging from 800-1000 psi. In the other hand, the increase of water cut of well CAT-07H and the remaining reservoir pressure (1549 psi) prevent this well to flow naturally [11]. Figure 2 shows the actual BHP survey of CAT-07H. From this data, it is known that CAT-07H is static 1000 ft fluid level.

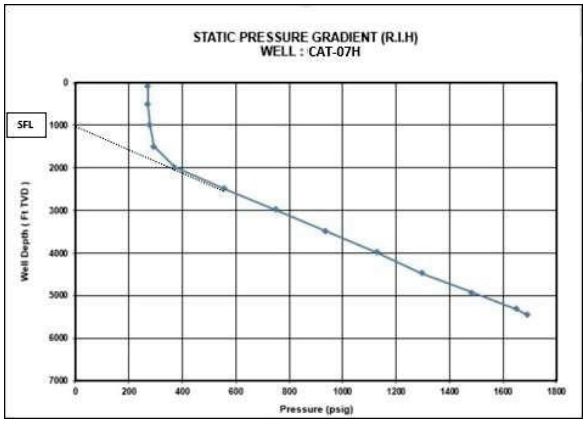

FIGURE 2. BHP Survey of CAT-07H

Evaluation of gas lift equilibrium curve (Fig. 3**)** was also made to see the effect of changing supply gas parameter to gas injection performance of CAT-07H. The evaluation was made based on the lowest possible casing pressure of CAT-07H which can be as low as 800 psi [12]. From the evaluation, it is known that with only 800 psi of casing pressure, gas lift gas gradient cannot reach the existing orifice depth located at 3412 ft. It is also known that with 800 psi casing pressure and 100 psi differential pressure across gas lift valve, the orifice should be located on 2900 psi.

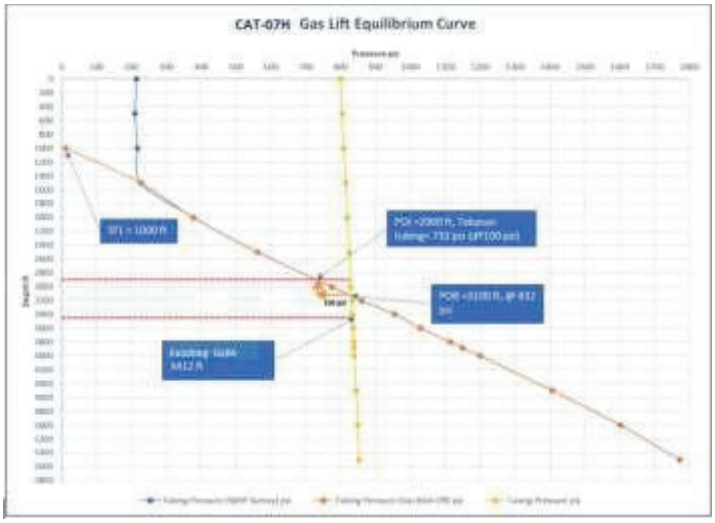

FIGURE 3. CAT-07H Gas Lift Equilibrium Curve

Nodal analysis of CAT-07H with original injection depth was made to evaluate whether CAT-07H was able to sustain flow naturally or not since the gas lift gas cannot enter the tubing due to the changing gas lift gas supply parameter (Fig. 4**)**. From the analysis, it is concluded that CAT-07H cannot be flown naturally.

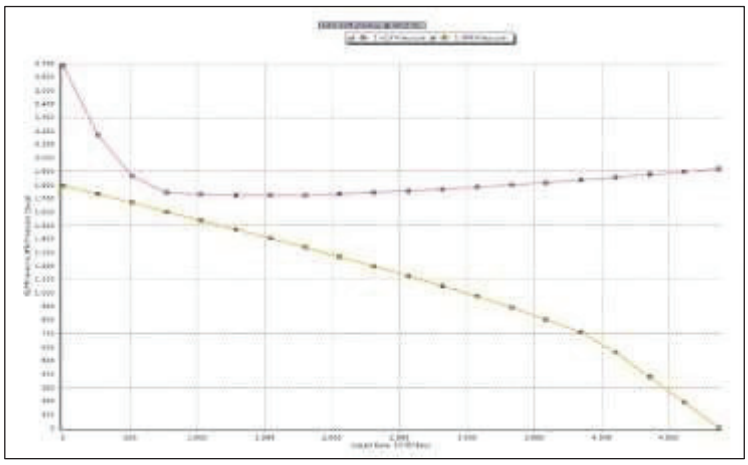

FIGURE 4. Nodal Analysis of CAT-07H with Original Gas Lift Injection Depth

Optimization of Gas Lift Parameter of CAT-07H

From the previous evaluation, it is confirmed that the problem that caused CAT-07H production problem is the insufficient casing pressure to gas lift this well with original injection depth. Optimization design of CAT-07H is based on the lowest possible injection pressure supplied by COM-182 which is 800 psi. Based on the gas equilibrium curve (Fig. 3) with 800 psi of casing pressure, the injection depth should be at 3100 ft. The next step

is to determine the optimum gas injection rate and the orifice port diameter with maximum gas supply of 1.5 MMSCFD and 800 psi casing pressure. Figure 5 shows the result of the sensitivity analysis of gas lift injection rate of CAT- 07H. Based on the analysis, the optimum injection rate is 0.3454 MMSCD with orifice port size 10/64 inch. With this optimum configuration and parameter, the well can be produced at rate
2532 BFPD/633BOPD or 54% of its maximum influx at 4870 BFPD as shown in Figure 6.

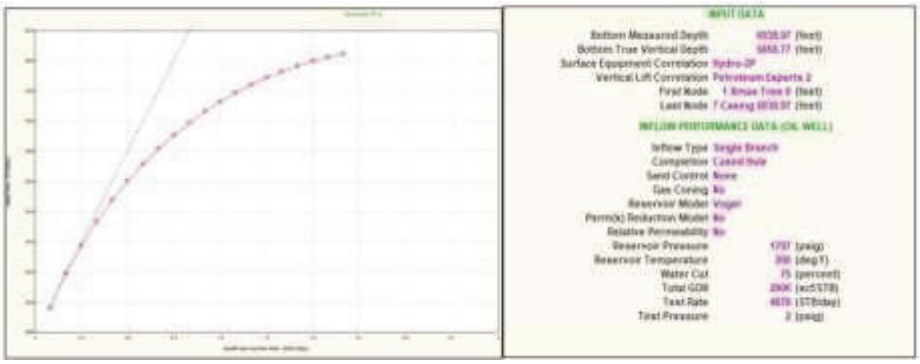

FIGURE 5. Optimum Gas Injection Rate Analysis

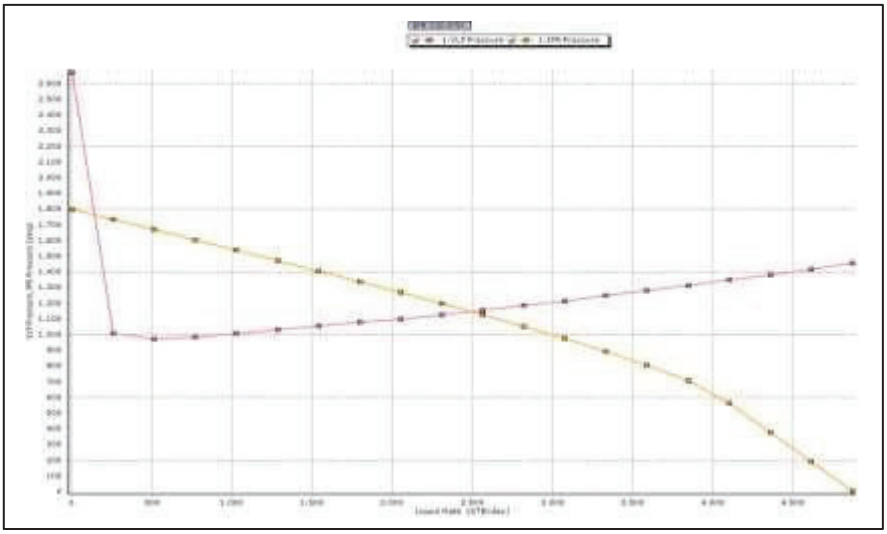

FIGURE 6. Nodal Analysis of Well CAT-07H with Optimum Parameter

Gas Lift Injection Depth Reposition Method

Table 1 shows the comparison of available well intervention method for repositioning gas lift injection depth. There are several methods that can be used to change the injection depth of CAT- 07H, they are: (1) conventional method, (2) permanent coiled tubing gas lift (PCTGL) method, (3) GLPO. Conventional method requires lifting to pull out production string to change the position of gas lift mandrel which is relatively expensive for an offshore oil well. PCTGL requires coiled tubing unit on site to run additional coiled tubing inside the existing production string and also requires modification of existing wellhead. The most feasible method in terms of delivery and cost is GLPO since it only needs slickline unit to punch tubing and install GLPO equipment.

TABLE 1. Cost and Delivery Comparison of Gas Injection Depth Repositioning Methods

Type of Intervention	Methode	Work duration	Total cost
Coiled Tubing	Change of injection depth with Permanent Coiled Tubing Gas Lift (PCTGL)	7 days	Rp 2,300,000,000.00
Hydraulic Workover Unit	Reposition Side Pocket Mandrel by removing the tubing circuit	10 days	Rp 4,690,000,000.00
Slickline (GLPO)	Reposition the injection point with doing tubing punch.	5 days	Rp 584,000,000.00

Implementation of GLPO at CAT-07H

The actual implementation of GLPO was in late April 2019. Figure 7 and 8 shows the documentation of GLPO Installation at well CAT-07H. The operation was done by creating hole on tubing using tubing puncher tool in order to create new passage for gas at desired depth and then installing GLPO equipment inside the tubing string at the punched interval which include pack offs and orifice port. Figure 9 shows the new well diagram of CAT-07H after GLPO installation.

FIGURE 7. Tubing Puncher Tool and GLPO Equipment

FIGURE 8. Puncher Tool Run Preparation

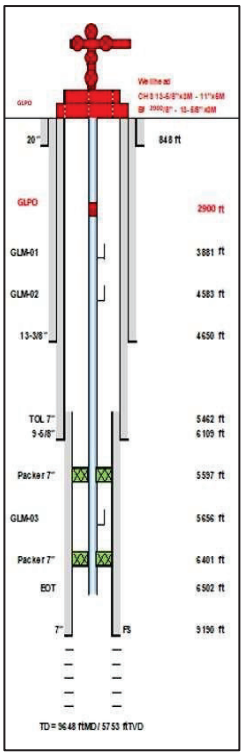

FIGURE 9. CAT-07H Well Diagram After GLPO Installation

Evaluation of GLPO Implementation at CAT-07H

From Fig. 10 and Fig. 11, it is known that CAT-07H had not been producing for about 7 months, which meant that Cath Field was losing 642 BOPD from those 7 months from CAT-07H [13]. However, several attempts had been conducted to try to start up the well before gas lift optimization but failed. Figure 11 shows the production history of CAT-07H before and after GLPO installation [15-16]. It shown that after the installation of GLPO, CAT-07H can be brought back into production with average production on Mei 2020 of 664 BOPD.

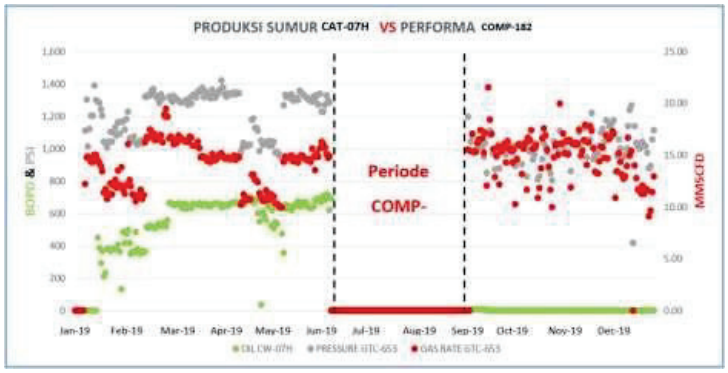

FIGURE 10. Performance History of COM-182 Compressor and CAT-07H

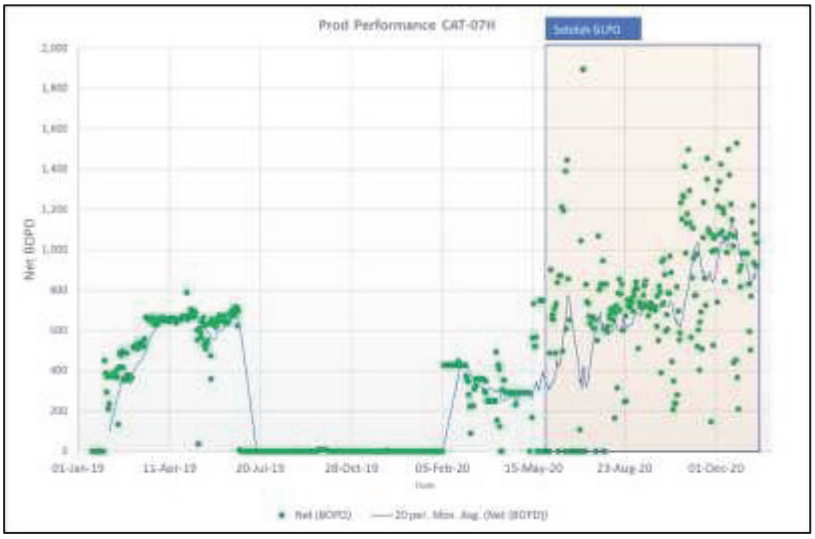

FIGURE 11. Production Performance of CAT-07H Before and After GLPO Implementation

CONCLUSIONS

From this paper, there are several conclusions regarding the optimization of gas lift on CAT-07H:

1. Original gas lift injection depth at 3142 ft was no longer optimum due to the decrease of gas lift pressure from COM-182 compressor.
2. With lowest possible scenario of gas lift injection pressure of 800 psi, the optimum injection depth is at 2900 ft with optimum gas injection rate of 0.3454 MMSCFD.
3. The implementation of GLPO as gas injection depth reposition method can reduce delivery time and cost if compares to other reposition method.
4. The implementation of GLPO at CAT-07H was successfully bring back CAT-07H into production at average production rate 662 BOPD on Mei 2020.

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