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Mono Trip Cement Through Gas Lift Completion: Innovative Completion System to Develop Oil-Gas Reservoirs in The Mahakam Delta

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MONO TRIP CEMENT THROUGH GAS LIFT COMPLETION: INNOVATIVE COMPLETION SYSTEM TO DEVELOP OIL-GAS RESERVOIRS IN THE MAHAKAM DELTA

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Pertamina Hulu Mahakam

Abstract

Handil is a mature oil and gas field located in the Mahakam block, East Kalimantan, Indonesia, which has been produced since 1975. Until now, oil from this field has contributed at least 70% of the total oil production produced from Mahakam block where 90% of the wells are using gas lift technology.

The utilization of gas lift technology has evolved in such a way that began with the use of dual strings with Side Pocket Mandrel (SPM), Retrievable Gas Lift (REGAL) which uses Gas Lift Pack-Off and Gas Lift Macaroni to increase lifting capacity through workover activities, to the latest using a technology called Mono Trip Cement Through Gas Lift Completion or abbreviated as MTGL which significantly reduce completion cost.

The main objective of this paper is to share the experience of the MTGL system installation in two (2) Handil wells in the end of 2017. The utilization of this system has had a significant impact to increase well economy by reducing rig operation time to 1.3 days per well and avoid potential future workover cost to install gas lift system in the wells that were not previously equipped with gas lift system.

Keywords: Handil oil and gas field, Mahakam block, Mono Trip Cement Through Gas Lift, Monobore.

1. Introduction

Handil is an oil and gas field with an area of 40 km^2 where the reservoir consists of multi-layer reservoirs which has produced oil and gas of more than 900 MMb and 2 Tcf. The reservoir layer depth is between 300 m to 4,000 mMD with a permeability range between 10 and 2,000 mD. Based on the reservoir layer depth, Handil field is categorized into three (3); Handil Deep Zone, Handil Main and Handil Shallow Zone (**Figure 1**).

Until now, more than 90% of Handil wells are produced using gas lift method and it becomes a "backbone" for Handil production recently (Ashfahani & Kusuma, 2017). In order to support gas lift installation, the well architecture was designed in such a way using dual monobore completion type where the lower completion string was installed and hung using a liner hanger followed by cementing process and ended with the installation of upper completion assemblies (**Figure 2**).

Although this type of well architecture has been applied for several years in Handil field, the overall rig operating time needed to complete this type of well is considered time consuming and less economical.

Based on these facts, Handil wells with monobore completion was chosen as an option, where the tubing and other completion jewelries were installed and cemented directly at the completion stage (one trip). However, the drawback of this design is the absence of any gas lift system as the well starts to deplete due to current gas lift technology at the market is categorized as non-cement tolerant.

Besides that, since the production packer was not used in this type of completion, it would not be possible to cut above the cement and run completion string with gas lift components as there would be no positive seal to allow safe operation of gas lift. Therefore the necessity to have modification for gas lift system installation is required, such as using macaroni pipe utilization through workover activities.

Based on these challenges, Mono Trip Cement Through Gas Lift Completion or commonly called MTGL comes as a solution to overcome these limitations (**Figure 2**).

2. Mono Trip Gas Lift System

The MTGL system is based on true monobore design with one-trip gas lift system deployment capabilities. More importantly the system will operate as intended after cement has been pumped through each of the components which normally called cement tolerant. The meaning of cement tolerant itself is the ability of the equipment to be able to be passed through by cement during the cementing process.

The main concern of this system is the functionality of all equipment components, especially Side Pocket Mandrel (SPM) and Downhole Safety Valve (DHSV) after completing the cementing process.

To accommodate the cleaning process of equipment from residual cement, the MTGL system is combined with an annulus production packer that can be set hydraulically and also a device that allows high circulation rate between tubing and annulus. This device can give an access for direct circulation to clean residual cement by creating turbulence flow through high circulating rate. The purpose of this circulation is to eliminate the risk of SPM and DHSV system damage due to potential clogged parts with residual sludge or cement that may be left behind after cementing process.

In general, this MTGL system consists of following components (**Figure 3**):

a. Cement thru Downhole Safety Valve (DHSV)

This tool is a valve used to shut-in the well in emergency situations or catastrophic event. Unlike the conventional DHSV, the cement thru DHSV is equipped with special o-ring that serves as dirt or debris barrier that protects and isolates the control chamber and the spring cavity from the hydraulic fluid pumped.

b. Cement tolerant Side Pocket Mandrel (include the Gas Lift Valve)

This tool allows the gas lift valve to be installed and retrieved from inside the mandrel with slickline operations. This tool is designed in such a way that the internal part of the valve is equipped with internal vanes that allow creating turbulence effect during circulation to clean the annulus from the remaining mud or residual cement.

c. Hydrostatic Closed Circulation Valve (HCCV)

This tool is a key to the success of the completion. The main purpose of this component is to clean excess cement from the annulus allowing the Gas Lift portion of the completion to be utilized. The opening and closing of this component is achieved through pressure cycles. The first pressure cycle will open the rupture disc, and the second will close the outer sleeve.

In the application, the outer sleeve feature can be closed by applying pressure to the tubing (with the lateral valve closed) with a certain value and finally create isolation between the tubing and annulus, so that the final tubing integrity test can be performed after annulus clean up finished.

Besides that, there is also an interal sleeve that acts as a redundant seal from tubing to annulus. This inner sleeve is closed mechanically using slickline (BO standard shifter).

d. Annulus production packer

This packer is installed below HCCV. It is utilized to isolate and maintain cement placement and integrity when starting pressure cycles. It is also assures a positive seal for gas lift operations in the future. In addition, this tool also acts as a secondary well barrier.

e. Shoe Track Equipment

Landing Collar
This tool is used to land and lock (in rotational) wiper plug.

Float Collar & Float Shoe
This tool is used to prevent cement back flow from the annulus to the tubing.

Pump Down (Wiper) Plug Assembly
This tool is used to separate the fluid displacement from cement slurry during cementing operation.

3. Case Histories and Methodology

There are two Handil wells selected as filed trial, named as H-X and H-XY well. These two wells are designed in such a way to accommodate MTGL criteria and equipments by taking into account some technical considerations which affect the design of installed equipment i.e shoe track length, fluid density, pressure and circulation rate and the most important is the whole pressure cycles inside tubing (**Figure 4**).

3.1 Well data and characteristic

Well data and characteristic that can be obtained from these 2 wells are:

- The casing and tubing configuration consists of :
  - a 20” conductor pipe (CP) at ± 120 mMD/mTVD.
  - b 9-5/8” casing shoe at ± 1700 mMD/mTVD
  - c 3-1/2” Production tubing at ± 3,000 mMD/mTVD.
- Well inclination < 35 deg.
- Fluid density.

- Annulus packer at 100 m above 9-5/8” casing shoe.
- Cement design to put at minimum 50 m above the annulus packer.

3.2 Operation Sequence

The general operation sequences are as follows:

a. Retrieve wear bushing and jet wellhead.
b. Make up tubing running equipment.
c. Make up and run tubing with MTGL components.
d. Run and set tubing hanger.
e. Perform cementing operation.
f. After cement bump indicated, increase pressure inside tubing to 3,300 psi to set annulus packer .
g. Bleed-off pressure inside tubing to check floating equipment integrity.
h. Perform packer integrity test from the annulus to 1,000 psi.
i. Pressure up tubing to 5,200 psi to burst HCCV rupture disc to allow communication between tubing and annulus.
j. Perform tubing-annulus circulation to clean out excess cement, spacer and mud in the annulus.
k. Once completed, close annulus valve and continue pressure up tubing to 3,600 psi to close HCCV outer sleeve.
l. Increase pressure to 5,200 psi to ensure tubing integrity.
m. Inflow test DHSV with 2,500 psi differential pressure.
n. Pressure up annulus to 3,000 psi to ensure annulus integrity.
o. Rig up slickline equipment and install Back Pressure Valve (BPV).
p. Nipple down BOP and continue nipple up X-Mas tree.

3.3 Results and Discussion

These are several notes and lessons learnt captured from these two field trials in relation to the cementing design and process, equipment activation through pressure cycles and annulus cleaning strategy as below:

a. The cementing fluid design compare to the annulus cleaning procedure & timing.

Due to final pressure test will be applied in tubing and annulus to confirm overall well integrity, the way and duration of annulus cleaning become critical, considering large volume in the annulus (> 50 m^3). It is related to the cement pumped into well, where the formulation is designed with critical static gel strength cement period in the range of 5-6 hours to accommodate whole pressure cycles after cement bump.

In the situation where the pressure cycles duration after “bump plug” considered more than 5-6 hours, which means beyond critical static gel strength designs then production issues such as micro annulus and cross flow between reservoir zones may occur due to poor cement quality behind casing.

b. Annulus packer integrity once set.

There is no guarantee once the packer set properly after cementing operation prior to annulus pressure test completed and give good results. In case the packer integrity test is negative thus there is a risk of both cement and formation below packer exposed to high pressure which could fracture the formation and create severe losses at the same time.

Prompt preventive action was taken from the first well trial to put low pressure value (1,000 psi) in the annulus just to confirm the packer set. The test was carried out in step of 200 psi increment per minute. In every pressure increment, the fluid volume pumped has to be compared with the volume test calculation. Re-pressure test the packer once remaining pressure cycles completed to higher value (3,000 psi).

c. **Gas lift valves condition after well completed.**

Through the intervention process after the first well trial, all of gas lift dummy valves installed in Side Pocket Mandrel can be retrieved without any operation issues. This retrieving activity proves that MTGL system can be the best option as cement tolerant system for gas lift installation.

d. **The cement integrity evaluation.**

As the evaluation of overall fluid (mud, cement, spacer, brine, etc) design strategies pumped during cementing, Cement Bond Log (CBL) was also performed in these two wells and showing positive results where the CBL value was at an average of 10 mV.

In overall, the success of the MTGL system implementation could not be achieved without proper technical analysis and precise calculations between fluid composition and correct procedure and timing for activation of some MTGL components installed, therefore all completion stages take place according to plan without major issues.

4. Conclusions

Preparation stage for equipment and material (**Figure 5 & 6**) followed with comprehensive coordination between multi-disciplinary teams (Well Construction & Intervention, Geosciences & Reservoirs and Field Operation) in Balikpapan, workshop and rig personnels, become key success of the MTGL system trial in Mahakam.

In spite of some issues experienced during the trial, MTGL system is considered as the best option able to replace the incumbent, dual monobore system which takes longer time and also directly eliminate the option to do workover operation in the future to install gas lift system (Gas Lift Macaroni and Gas Lift Pack-off) on monobore type wells that were not initially equipped with gas lift system.

Unique and smart design from MTGL also able to increases the efficiency of rig operating time by reducing the slickline operation during the completion phase. Total time efficiency by 2.5 days (**Figure 7**) and estimated workover cost savings of USD 1,000 K are obtained from these two Handil wells. This certainly has the effect of reducing operating costs and significant job risks for Pertamina Hulu Mahakam as an operator and it is expected to become future completion architecture for oil wells in Handil and other Mahakam field such as Bekapai.

Some recommendations and suggestions have been noted and will be implemented for next campaign, to be specific in terms of optimizing some critical procedures such as flow rates during annulus clean up and running speed of tubing and other equipment installation.

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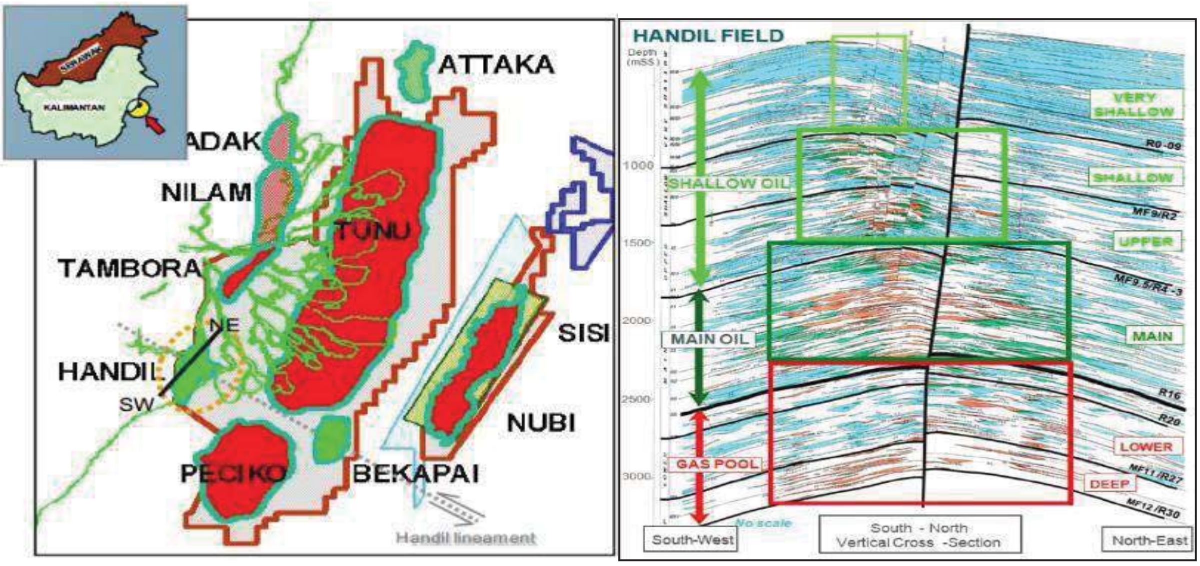

Figure 1 - Handil Field Location (top) dan Handil Reservoir Layer (bottom)

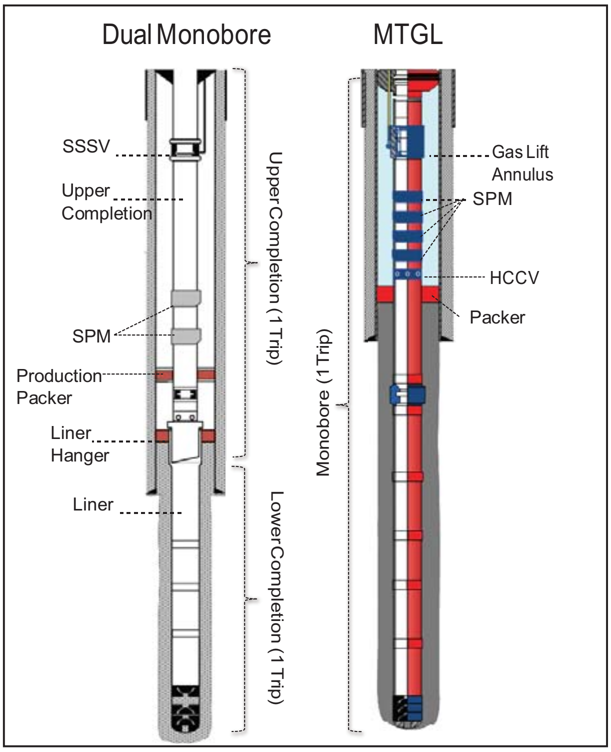

Figure 2 - Dual Monobore (left) vs MTGL Completion Schematic (right)

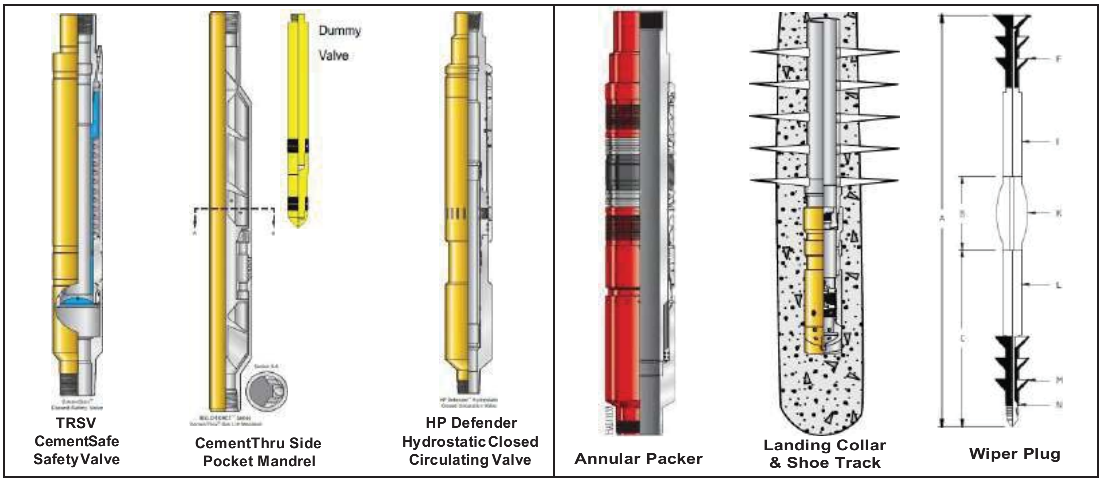

Figure 3 - Primary Components of MTGL system

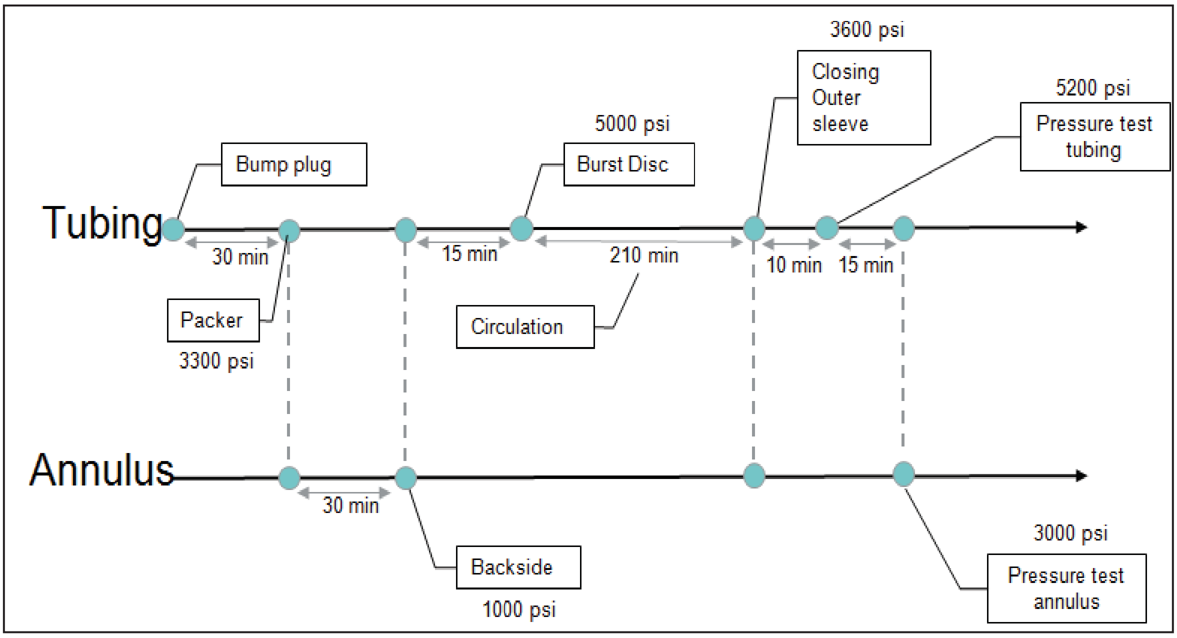

Figure 4 – Typical MTGL Pressure Cycles

Figure 5 - Drift (Pump) Through Cement Wiper Plug into Cementing Head in Drilling Workshop

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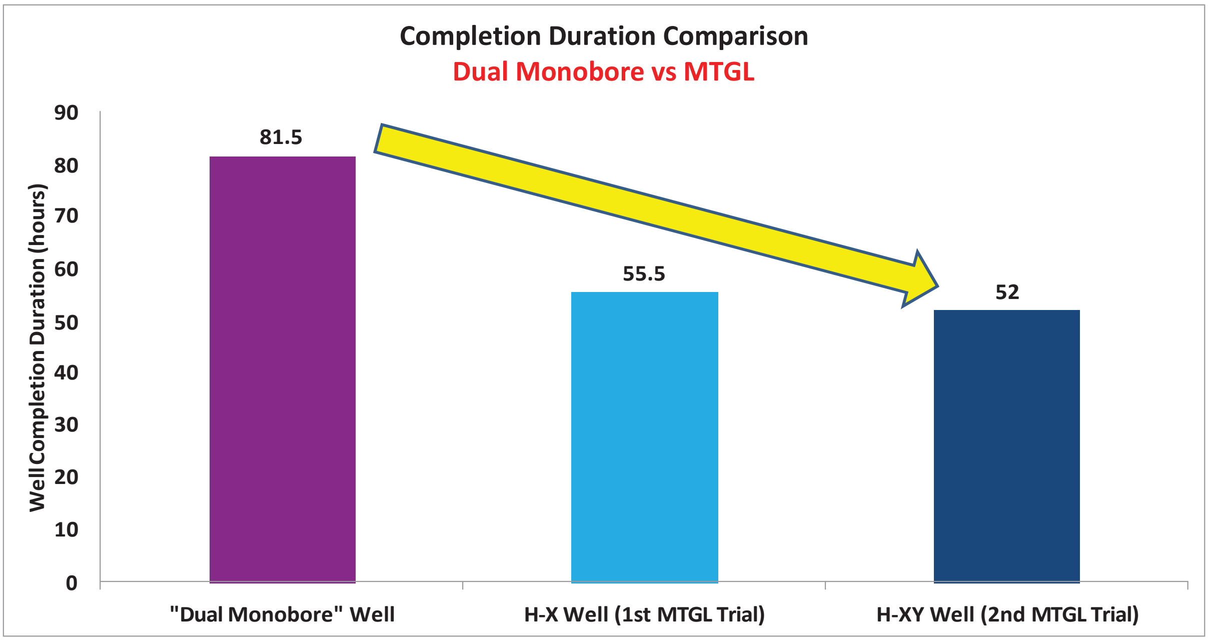

Figure 7 - Completion Duration Comparison Dual Monobore vs MTGL