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New Technical Approach on Annulus Cementing with Coil Tubing Packer in Oil well and Gas well at Mahakam Fields

SIMPOSIUM IATMI 2018
PADANG| 1-3 OKTOBER 2018

New Technical Approach on Annulus Cementing with Coil Tubing Packer in Oil well and Gas well at Mahakam Fields, Indonesia

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Pertamina Hulu Mahakam

Abstract

PHM fields are located in The Mahakam Delta and Offshore area in East Kalimantan, Indonesia. Most of the wells are multizones gas producers completed with cemented tubing which cover only main zone, but for shallower reservoirs are not targeted until recent years.

To unlock shallow reservoir target, annulus cementing is required as well barrier prior perforation.

There are several conventional methods of annulus cementing which have been implemented in Mahakam well intervention activities, such as :

a. Annulus cementing with balance method
b. Annulus cementing with cement retainer

Sisi nubi well is one of well case study annulus cementing with conventional method using balance method that have failure during cementing job and create cement flow back to the tubing. Consequently required additional intervention to clear access by milling and under reaming operations that cost up to USD 627,000. Well Intervention division continuously looking for new method to reduce operating time and cost efficiency.

Annulus Cementing with Coil Tubing (CT) packer is a new method to perform annulus cementing resulting clean wellbore and high quality cement in the annulus.

This method has been successfully implemented in 7 wells in Offshore field with satisfactory result.

The principle of annulus cementing with CT packer is temporary set on the well bore to prevent upward and downward movement of fluid or pressure during and after cementing operation, and also to avoid cement contamination with wellbore fluid.

Following the success in offshore field application, thus the division extend the application in the fields at Delta area.

Keywords: Annulus cementing, Packer, Coil tubing, Delta Mahakam, Offshore

1. Introduction

Pertamina Hulu Mahakam (PHM) wells completed with typical completion such as monobore completion, multiples string completion and tubingless completion in 4-1/2" tubing 13.5# C-95 Cr 13 Vam Top NE with drift 3.83" and completed 9-5/8" casing as annulus #A. Area of PHM are located in the Mahakam river delta (Tunu) and offshore (Peciko, Bekapai, Sisi Nubi and South Mahakam) in the province of East Kalimantan, Indonesia. Most of well is gas producer from multi zone reservoirs with cement barrier recover only in main zone (main zone : 2500 – 4000 tMD) cause of efficiency cementing job was recover only the reservoir that will produce (main zone) and the shallow reservoirs were not targeted until recent year which is not recovered cement barrier. With progressing depletion of deep reservoir in the main zone and bottom up perforation strategy the operator started perforating upper zone or shallow reservoir.

2. Annulus cement barrier

To unlock shallow reservoir target, annulus cementing is required as well barrier prior perforation.There are several conventional methods of annulus cementing which have been implemented in Mahakam well intervention activities, such as :

a. *Annulus cementing with cement retainer*.

Cement retainer is a bridge plug that modification with bottom part replaced with check valve that have function to counter back flow and to hold pressure during cementing process and after cementing job (Figure 1: cement retainer). Cement retainer set in tubing using electric line (wireline) after tubing punch or create communication between tubing to annulus. After cement retainer continue run CT for sting in job. Process for sting in job often have constrain in the field.

- First constrain is difficult to sting in to cement retainer that have potential the stinger will bend and affected to sealing part element cannot hold pressure during cementing job or after cementing job.
- Second constrain is cement retainer will set permanently in the tubing that make the well will difficult to re access in case need to perform intervention and production in main zone reservoir.

b. Annulus cementing with balance method.

In order to re access well and to avoid permanent set of bridge plug or cement retainer set in the well. Annulus cementing with balance plug method is one alternative with principle to keep balance of fluid inside tubing with outside of annulus (cement), with the result that cement still inside the annulus and not flow back to inside tubing. Equation is shown by Eq.1 below:

$$F_1 = F_2$$

$$m_{tubing} \times g = m_{annulus} \times g \quad .. (1)$$

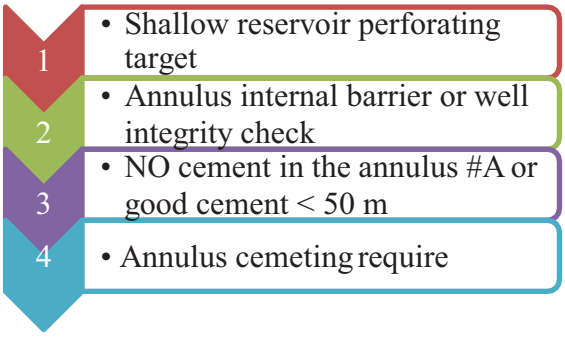
Annulus cementing with balance method require correct calculation to keep composition of fluid or weight of fluid are balance with inside tubing and fluid in the annulus. However best practice in the field to get balance fluid is difficult than just on the lab or by calculation. Due to unbalance fluid has create cement contamination and effected low cement quality. The biggest problem if cement not balance is cement flow back in to tubing.

In addition above, operation annulus cementing with balance method require additional jobs that is sediment wash or milling operation due to fluid that use for balance fluid inside tubing that have same specific gravity shall be to clean out in order to get well access for perforation after cementing job is complete.

See (figure 2: annulus cementing with balance method)

All above conventional method that use have several a weakness such as long time duration of annulus cementing job, leave debris in the well or well in the tubing become not clean due to still have remain cement or excesses balance fluid and high risk of failure. To perform annulus cementing job prior well produce from shallow reservoirs require internal barrier data, one of data require are deepness of cement in annulus #A, estimate of top of cement, well integrity status is green or yellow or orange or red, well will produce comingle reservoirs with main zone or other zone or just single reservoir only.

When cement in the annulus is not recovering reservoir that will produce or annulus cement less than < 50 m of good cement from the upper perforation target so annulus cementing job shall require.



Case history one of PHM well use annulus cementing with balance plug method in 4-1/2" tubing for annulus cementing from 2800 mBRT until 2475 mBRT prior perforation to open sahallow reservoir target SN3-29: 2727.5 – 2729.5 mBRT as per (figure 3: Well diagram), use this method due to there is cement retainer available on special tubing with ID = 3.825". During annulus cementing operation after perform all step above, found cement was return back to tubing until DHSV or TRSV depth due to unbalance fluid. Cause of that additional job milling operation and under reamer operation are requires to clean out tubing from cement debris in order to create tubing become normal and got clear access. All operation above has taken 28 days operation and was spends additional cost until 627,000 USD for tubing access recovery.

3. New methodology annulus cementing

With several problems above, new methodology of annulus cementing require to minimize risk and to reduce job duration of annulus cementing job to get more efficiency than using with conventional methods

Annulus cementing with CT packer is a new method of annulus cementing with coil and resulted clean tubing wall from cement remaining and no need additional job for clean out or no need sediment wash or no need milling operation to mill bridge plug (cement retainer), with this method able to get good cement quality result.

The principle of annulus cementing with CT packer is temporary set on the well bore to prevent upward and downward movement of fluid or pressure during and after cementing operation, and also to avoid cement contamination with wellbore fluid

Work principle of annulus cementing job same as normal annulus cementing activities with cover:

a. ***Preparation*:**
   Set a landing base with retrievable plug or bridge plug , continue tubing punch to create communication from tubing and annulus, circulate out tubing to annulus to get clean well bore from fluid remaining or debris in the tubing or in the annulus prior cementing job operation. After confirm all step will continue to next step for pumping cement with prepare cement mixing first.

   Mixing cement using batch mixer is one of operation that take until 18 hours due to we mix in the field by mixing several suck cement into batch mixer and mix with some chemical to get compressive strength as per design.

b. ***Pump cement*:**
   To pump cement from coil thru packer will consist of fluid corrosion inhibitor, spacer fluid, cement fluid and tail slurry that have function to avoid cement contamination and also able to clean remain cement inside coil or BHA from CT to minimize failure un retrievable of packer. After all fluid has been pumped will continue with pump drill water as cement pusher and end of drill water position during annulus cementing shall between tail and CT packer (Figure 3: CT packer) due to have function as room or area to retrieve packer after wait on cement (WOC) until 24 hour or compressive strength 3000 psi and finish.

CT packer has two principles or different two mechanisms: (Figure 4: Tension packer and inflatable pacer)

3.1. Tension set packer:

Packer inflates due to G slot mechanism and tension set packer with limited set in normal completion for 3-1/2" tubing unti 4-1/2" tubing.

Run CT tension packer until target depth or 20 m above punch hole and procedure to set tension up packer is tension up coil, tension down coil and last tension up coil with indication tension in the coil tubing will increase significant that indication if CT packer of tension pacer was set properly. Pressure test in the annulus require to confirm seal of CT packer is properly seal.

After confirm CT packer was seal, continue with annulus circulation with pumping thru coil and return in the annulus.

3.2. Inflatable packer:

Packer inflates due to fluid pumping to packer and inflatable packer used in un normal tubing condition such as well restriction, bigger completion from 5-1/2" tubing until 7" casing.

Run CT with inflatable packer until target depth or 20 m above punch hole and procedure to set inflatable packer is by drop ball ½" and pumping thru coil until ball sited in profile until indication pressure increase until 2000 psi to inflate the packer until maximum and break shear pin with indication pressure drop significant. CT packer is fully expand and test to move up and down until 1000 lbs if there is no movement of coil and confirm CT packer using inflatable packer was fully set and continue pressure test in the annulus require to confirm seal of CT packer is properly seal.

All packer above have maximum pressure rating until 10,000 psi.

4. Result and analysis

Annulus cementing with CT packer method has been done in 7 wells in

offshore area and 5 wells in Tunu delta Mahakam area in oil well and gas well with cement quality cement result with acnnulus cementing CT packer method is (AMP < 10 mV) as per (figure 5: CBL result) and without any constrains during annulus cementing job.

To anticipate or to avoid problem during annulus cementing with CT packer such as

a. **CT packer not sealing.**
   Pressure test shall be performed after packer set or inflate to ensure packer was holding properly prior annulus cementing job.
b. **CT packer cannot release after annulus cementing complete.**
   CT packer was complete with two mechanism incase CT packer cannot release, 1st mechanism is overpull mechanism until shear pin was shear and create packer deflated and second mechanism is drop ball to disconnect BHA and left packer left in hole in the tubing.

Operation annulus cementing with CT packer was reduce time duration from 12 days become 6 days with eliminate additional job such sediment wash or milling bridge plug and safe cost until 442,000 USD per well.

5. Conclusion and recommendation

Annulus cementing with CT packer technique has been approve method with good quality cement result with prevent upward and downward movement of fluid or pressure during and after cementing operation, fluid contamination or cement contamination can be avoided.

Operation annulus cementing packer able to reduce operating time with avoid additional operation and make cementing job more efficient and reduce cost of cementing job.

Room to be improve during annulus cementing job are

a. Time of cementing mixing, normally for cement mixing will require until 24 hours or more.

b. Wait on cement, need to reduce from 24 hours become less.

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List figures

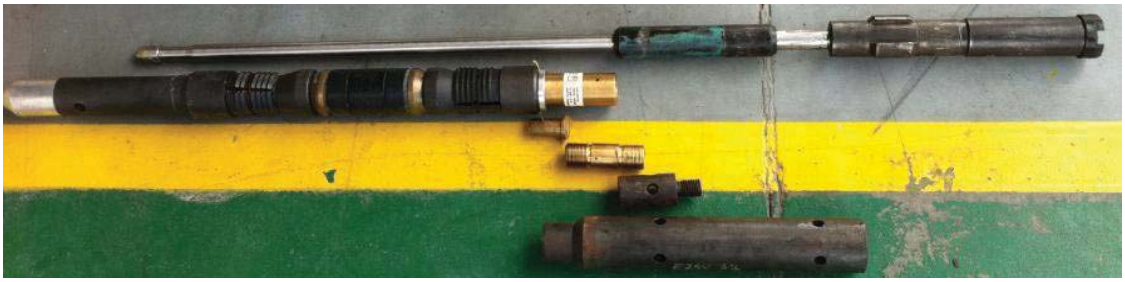

Figure 1: Cement retainer

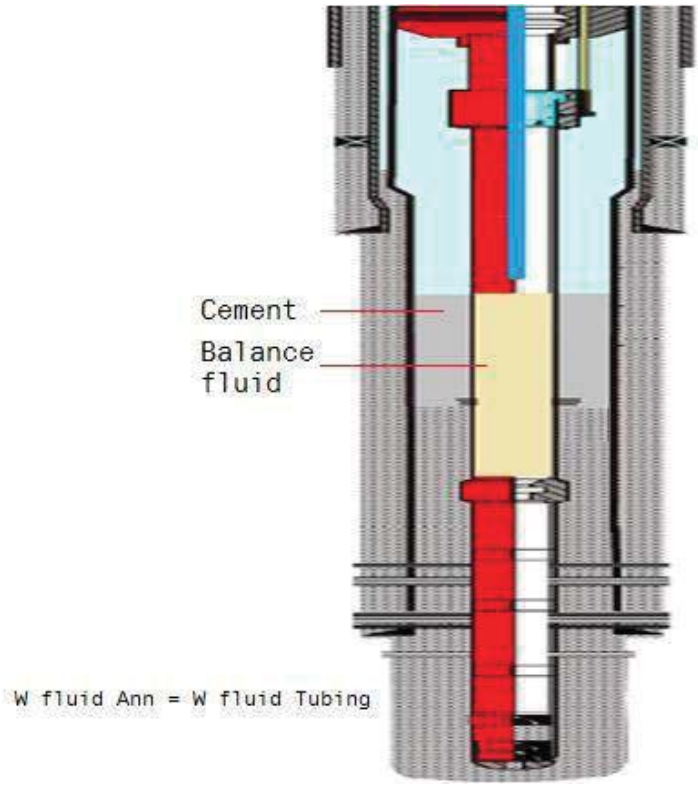

Figure 2: Annulus cementing with balance method

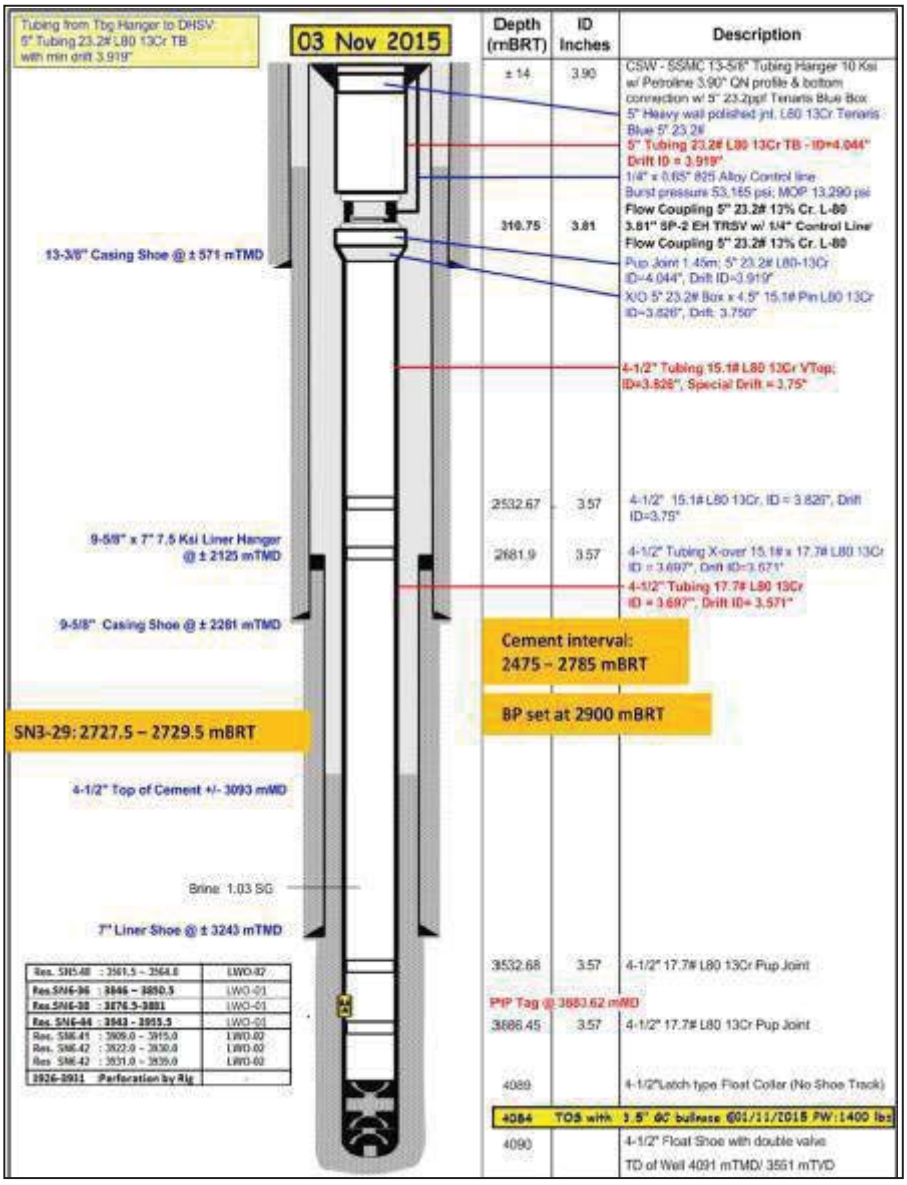

Figure 3: Well Diagram

Figure 4: Tension set packer and inflatable packer.

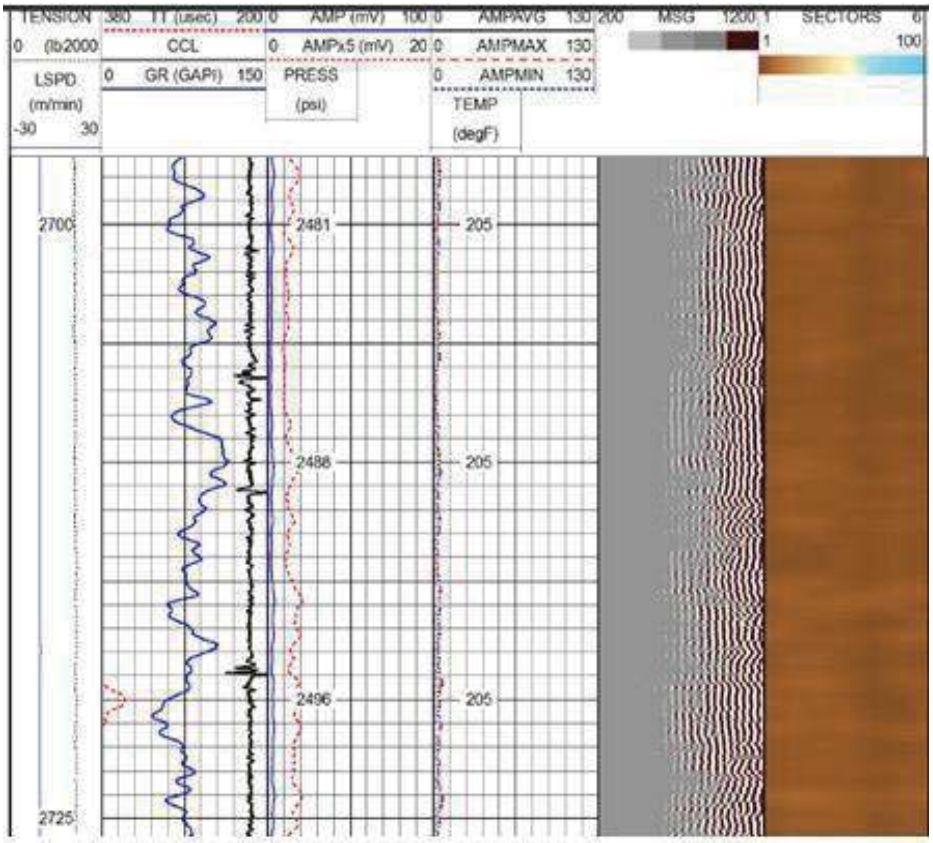

Figure 5: CBL result