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Lead Application to Cure Sap Wells by Deploying Straddle Packer, Success Story

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Abstract

Objective/Scope: The Increase of inactive wells due to subsurface integrity issue is observed in brown fields, Fig-1 is, showing the record for onshore UAE asset, the economic challenges is calling for alternative solutions to restore well integrity with lower cost.

Straddle packer application is consists of two tandom packers with spacer pipe in between with anchoring system deployed riglessly in the well to isolate the communication point between Ann A and Tubing.Fig-2,

Methods, Procedures, Process: Communication between tubing and annulus A (Failure of primary barrier) is identified as the right candidate wells for straddle packer application,

First step is to clearly identify the point of communication, it has been done by annulus pressure investigation excersize during flowing and shut in condition, observing the return of annulus fluid which was the same produced gas

Noise log has been conducted and clearly identified the communication point at SPM (Side Pocket Mandrel) to be used for emergency killing,

Tubing integrity test was conducted using nippless plugs and inflow test below and above the leak point and confirm no other leak points within the tubing

Engineering drawing for the leaking assembly was reviewed to design the dimension of straddle packer assembly, length and packer size

It is recommended to deploy the assembly using electric line correlation for accurate depth selection

After setting annulus pressure observed no build up

Well opened safely to production

Results/Observation/Conclusion: Leak point arrested, well primary barrier restored

Removed from DWS (drilling and workover schedule) and restore well production in addition to improving inactive string KPI for Gas asset

Save almost work over cost for gas well XX-197

Novel/ Additive information: The way forward is to check the scalability of extending this application among other ADNOC assets and to screen the right candidate wells for this application

To add this application as a part of well integrity procedures and recommendations for such like cases

Introduction

In one of ADNOC onshore assets with close monitoring to the inactive wells due to subsurface integrity issues along the past years, the recent increase of inactive wells due to subsurface integrity was observed, the main categories of subsurface issues can be summarized as below

- Communication between tubing and casing, SAP wells, Sustainable annulus pressure
- Casing corrosion, production Casing or intermediate casing.
- Completion equipment failure Such as packer leak, Malfunctioning of SCSSSV or Side Pocket Mandrel Leaking

Below Fig-1 is showing the number of inactive wells record by the end of the year covering the last 7 years as of December end of each year

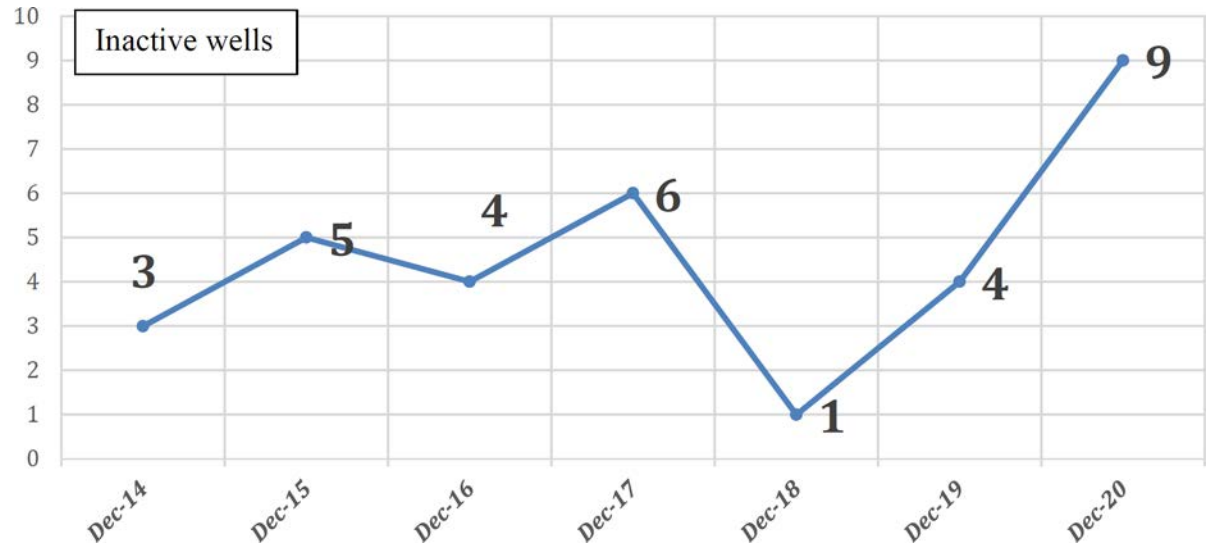

Figure 1—No. of inactive string due to subsurface issue

It is a clear observation there is an increase during the last year 2020, Although 5 workover wells was completed during 2020 still the inventory of wells is increasing, 2020 started with 4 wells and ended with 9 wells although 5 wells was treated, 10 wells was added to this list during 2020, it needs intervention to restore normal production or injection of wells

The most likely causes was well aging, completion design in addition to other causes which is under investigation with integrity team

This observation was alarming to management, which incorporate production and injection deficit due to unavailability of wells

Exploring alternative solution was recommended to meet the main below objectives

- Cost optimization, minimize rig workover activities
- Reduce risk

- Quick solution
- Improve asset KPI for inactive string record and production mandate
- Promoting new applications and technologies

Straddle Packer was introduced as one of the applications and technologies endorsed by asset management to be utilized, considering it nature as Rigless and through tubing solution

What is the straddle packer?

Simply it is two tandem packer elements with spacer pipe in between in addition to anchoring system to be set across the point of communication to isolate the interval of concern whether it is a communication point between tubing and annulus or it is corroded interval or it is a malfunctioning completion accessory, allowing the fluid to pass through bypassing the point of interest, Each Packer Module consists of a one-piece solid elastomer element supported by a tight mechanical barrier on each side. When expanded, a radial wall prevents extrusion of the packer element under strain or pressure.

The one used in this paper excersize it is a single run system set by electric setting tool deployed by electric line with, also it is through tubing rigless retrievable solution.

Figure 2—Straddle packer assembly

Bottom packer

Anchoring Slips

Top packer

Straddle packer potential Application

The main function is to straddle undesired area, application is upon end user objective below just and examples,

Gas lift straddle
Screen straddle
Water-shut off straddle
Tubing repair straddle
Insert safety valve straddle
PBR straddle

Application might be used as permanent or temporary solution until workover operation

Straddle packer application main feature

- Can be run on Slickline, E-line, CT and pipe
- It has various applications on-site
- Ideal for workover applications
- Slim design (small OD/large ID)
- Different sizes available upon tubing and casing size (7″, 5.5″, 4.5″ and 3.5″ tubing)

Candidate wells selection criteria

The proper candidate well selection is the main way to get the job completed successfully, Rush selection without full review of well status, well history and the capabilities of the target application always are the main reason behind missing the objective

Screening process of candidate wells was considering the below

- To have a clear identified single communication point between annulus and casing, short intervals
- No other subsurface integrity issues marked (No packer leak, no corrosion and no SAP in Annulus B observed)
- Well completion minimum ID is suitable to run the assembly OD
- Tubing integrity above and below the point of communication is confirmed, no other leak point
- Well fluid H2S and CO2 content to be considered is the assembly design and material selection.
- The future well intervention operation
- Well production or injection target,
- Maintaining down hole inhibition to comply with well completion design

The list of inactive wells was filtered against above consideration with service provider field operation well XX-197 onshore gas well was initially selected as the best candidate

XX-197 Well history

Well XX-197 drilled on 1983 as vertical gas producer well in a huge gas reservoir producing under depletion mode with no reservoir pressure support, well is completed with 5.5″ × 4.5″ tubing size, completion is equipped with two Side Pocket mandrels (SPM) The top one for emergency killing through annulus with (SRV Shear Relief Valve installed to be sheared by applying pressure in annulus to create communication with tubing), the bottom (side Pocket Mandrel), SPM, is equipped with gas lift vale used for chemical injection for downhole chemical inhibition purposes, inhibited diesel is pump through annulus to have downhole chemical inhibition as well completion material is carbon steel

Well production H2S content is 4.8% and CO2 content is 6.2%

Last production test dated Aug-20 well is producing 10.8 MMSCFD and 58 bbls condensate per day

With routine wells monitoring activities on Sep-2020 abnormal annulus A pressure was observed

In order to conclude the case further investigations was conducted as follows

1. Annulus A pressure bleed off and buildup data response with Wellhead pressure in both shut in and flowing condition which confirmed the sustainable annulus pressure due to communication between annulus and tubing, annulus pressure was unbleedable, both pressures WHP and Ann.A pressure was equal 66 bar
2. Gas composition analysis of Annulus A return was showing the same reservoir fluid composition
3. Setting dummy valve in lower SPM to avoid having multiple communication points between tubing and annulus
4. To accurately identify the leak point across completion, noise/Temp log was conducted, below steps was followed
    - **Shut in pass**

      Running the NOISE/TEMP log while annulus pressure is at maximum build up (equal to WHP) RIH with normal speed while POOH with stops as per program design
    - **Bleed off pass**

On the other hand, flowing pass, after bleed off annulus pressure to zero (as applicable) repeated the same up pass with same stops to compare both passes

- Finally identified clearly the main communication point is at top SPM at depth 8067 ft RTKB Fig-3

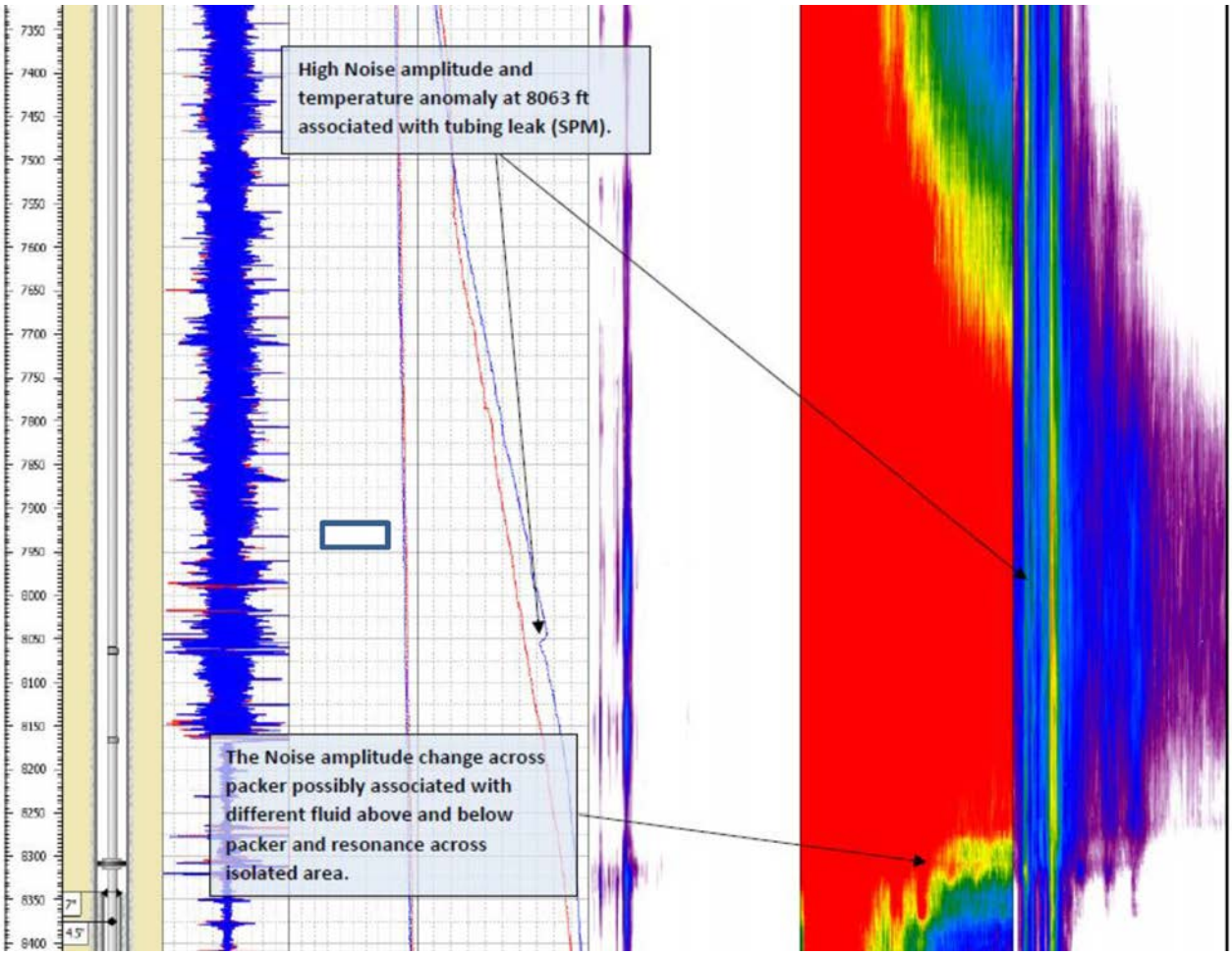

Figure 3—Noise/TEMP log graph as SPM depth

As shown below the high intensive noise was observed at SPM depth in which is supported by temperature anomaly at the same depth which is supporting the conclusion of having gas flow at this point

With collected above data, the well case was presented to the company central Integrity committee and endorsed as SAP case (Sustainable Annulus Pressure case) with below required actions

- To shut in the well as it is not safe to produce G\Given the failure of primary barrier (Tubing)
- kill and secure well as per company procedures
- Schedule the well for Workover to cure SAP case

As additional data gathering corrosion log was conducted to ensure well barriers integrity by running electromagnetic log to verify 9 5/8″ production casing which detected no abnormal metal loss

Wells data was shared with straddle packer service provider, mutually agreed it is a proper candidate and the required 4.5″ size of straddle packer assembly is available

Provided the well is inactive and scheduled for workover with rig, all stake hoders support was granted to try a new application

The team has discussed the case and below program outlines was agreed to be followed

1. **Tubing integrity confirmation**

    - As a learning lesson from experience, confirming the tubing integrity is required before job execution to ensure the single communication point is the one meant for intervention
    - Noise log was one indication but to be more confident tubing integrity excersize to be followed To avoid curing one interval and other points are still leaking
    - The general idea is to set plug below the leaking point and confirm the lower completion is holding pressure and again to repeat the same steps by setting the plug on top of the leak point to confirm the integrity of top completion

As it is gas well inflow test was followed by setting Nippless plug, below steps was conducted

1. RIH with Kick over tool on slick line, tagged the middle of the SPM as the main reference depth, flagged the wire, POOH.
2. RIH with 4.5″ Nippless plug using slick line, set same 10 ft below the flagged wire depth, confirmed setting by weight loss and tagging the plug after setting and release the setting tool to confirm plug is in place POOH
3. Bleed off annulus and tubing pressure from 970 psi to 800 psi, observed overnight.
4. No pressure build up in tubing or annulus was observed
5. RIH with pulling tool and retrieved the plug

It is a confirmation the lower completion (packer and tubing below the SPM) is holding pressure
In order to confirm upper completion integrity above the SPM below steps was followed :

6. RIH with 4.5″ Nippless plug using slick line, set same 10 ft above the flagged wire depth, confirmed setting by weight loss and tagging the plug after setting and release the setting tool to confirm plug is in place POOH
1. Bleed off tubing pressure from 970 psi to 800 psi, (Annulus pressure no change) observed overnight.
2. No pressure build up in tubing
3. RIH with pulling tool and retrieved the plug

As no pressure build up was observed in tubing side, with above excersize it is a confirmation for below

- ➢ Tubing has only single communication point
- ➢ Setting plugs in this old tubing (37 years) is holding pressure which mean the internal surface of tubing is in a good condition and setting the straddle packer is valid
- ➢ The minimum length of the spacer pipe between the two packer elements should be more than 20 ft length

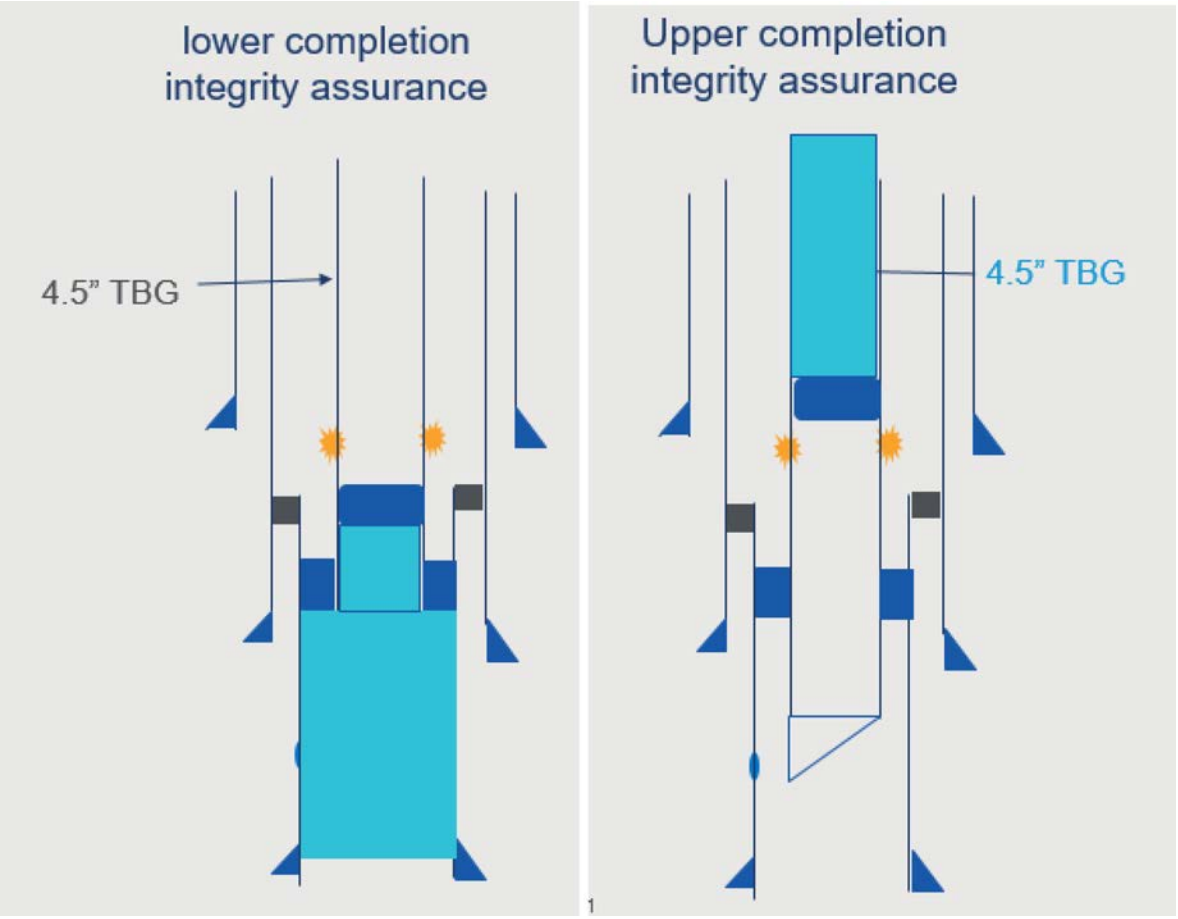

Figure 4—Tubing integrity assurance excersize

Why positive pressure test was not recommended?

Setting downhole plug and conducting pressure test using fluid pump was not considered as from experience pressurizing the tubing specially in old wells most likely will result in rust accumulation on top the plug which will make plug retrieval difficult and operation implications might be faced, also in XX-197 case there is other issue the reservoir pressure is low (+/- 1200) psi accordingly having 8000 ft water column on top of the plug to conduct pressure test will result in excessive differential pressure from top side accordingly plug retrieval will be a challenge.

Straddle packer configuration and design parameters

- The diagram of the leaking completion equipment, SPM, was used to properly select the length and OD of the straddle packer assembly
- The length of the spacer pipe to be more than 20 ft referring to the tubing integrity test conducted
- The pressure and temperature rating to be suitable for flowing and shut in condition of the reservoir (assembly rating was 5000 psi and 300 degree F which is suitable to XX-197 well case)
- The maximum differential pressure across the straddle packer assembly was calculated on the maximum pressure can be applied in annulus with hydrostatic column and the wellbore pressure (3500 psi assembly rating is suitable for the well condition)
- Minimum ID after above considerations is 2.1 inch which is acceptable to handle the maximum well production,10 MMSCFD.

Main challenges expected during lowering assembly and job execution

- **Depth correlation**
  In order to set the straddle packer assembly exactly against the desired depth it was agreed to lower assembly using Electric line to have correlation facilities using CCL log as the well is very old and well completion items need verification and dimensions confirmation
- 3 stories scaffolding around the well head was required to enable safe R/U of assembly before RIH, total assembly length is 35 ft including (straddle packer assembly, setting tool, CCL correlation and EL BHA)
- Putting grease on the assembly to facilitate RIH due to limited clearance between tubing ID and assembly OD
- Compatibility between setting tool and EL setting kit which was confirmed offline in the workshop
- The weight of the assembly and selecting the proper EL size, all calculations was done offline and the proper cable size was selected
- Equipment rated for H2S and CO2 content of the well fluid

Straddle packer Setting steps

- Carried out Slickline dummy run with 3.75″ Gauge cutter (Assembly OD is 3.63″)
- RIH with assembly on EL (Setting tool, CCL and BHA)
- Correlate depth with CCL against the completion items, clearly identified the SPM of concern
- RIH and stop at CCL pre-calculated depth
- Electrically activate the setting tool, good indication of setting it takes 15 minutes for full setting of elements, good indication of weight loss
- POOH, retag the assembly, confirmed it is in place
- At surface lay down the setting tool, good electric signature of tool working properly

Post assembly setting evaluation

After POOH and before releasing equipment and service provider

➢ Immediately started annulus pressure bleed off to green burner to ensure arresting the communication point

Below is the annulus pressure graph showing WHP is 66 bar and annulus pressure is 5 bars then zero bar with no pressure build up in annulus side, Which is a clear confirmation the leaking completion accessory was isolated with Fig-5

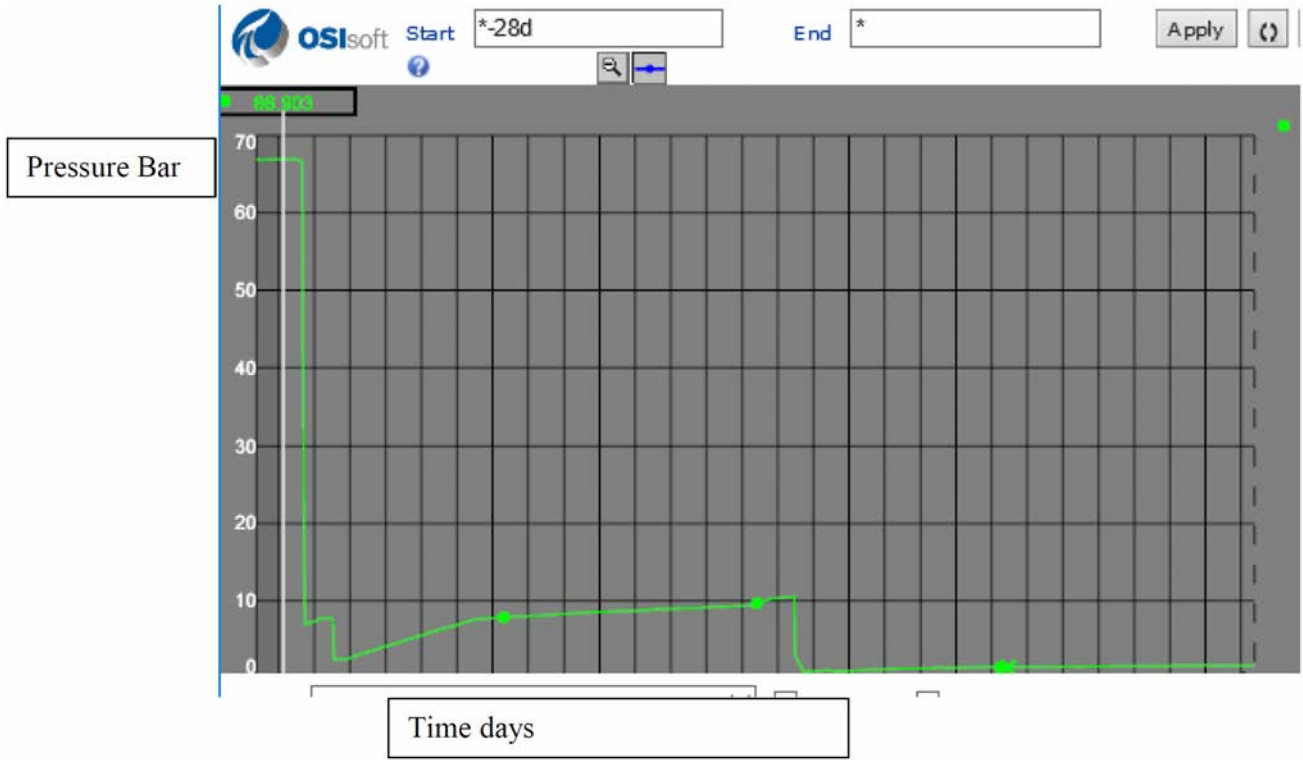

Figure 5—Annulus A pressure graph post setting straddle packer assembly

Make the operational arrangements to line up the well to production facility
Opened the well initially to green burner to have less backpressure till getting pure gas
Diverted well to production gradually till getting the target rate

Case has been evaluated and announced successful, represented the case to THE company central integrity committee and granted support and approval to flow the well back with close observation for annulus pressure

Added value

1. Well activation improving inactive string KPI and records.
2. 10 MMSCFD and 50 bpd condensate Production restoration
3. Well removal from rig schedule saving Workover rig cost,
4. Saving the cost of wellhead flow line loop dismantling and reinstatement
5. Proving the application to be utilized in similar future situations and to be considered as a standard solution for such like cases

Overall evaluation of straddle packer

Pros:

- ❑ Rigless solution
- ❑ Retrievable
- ❑ Relatively cheap solution comparing to W/O rig
- ❑ Fast Mobilization and setting

Cons:

- ❑ Limited well intervention activities post setting assembly due to ID restrictions (slim tools might be used)

- ❑ Not valid for all well integrity related issues
- ❑ Curing long intervals
- ❑ Other Expected challenges with
  - ➢ Highly deviated section
  - ➢ Wells suffering from frequent scale accumulation
  - ➢ Potential impact of high producer/Injector wells

Expected future promotion of application

- ➢ With several jobs implementation experience build up and accumulation will be in place to reduce cost and optimize operation timing
- ➢ Multi run straddle packer assembly might be used to cure longer intervals using the same concept

General conclusion

The main factors behind this project success is:

1. Proper selecting of the candidate well
   - ➢ All the history data to properly reviewed
   - ➢ The assembly design sheet to be reviewed
   - ➢ Future well activity and production to be considered
2. The teamwork spirit and having single objective among all team members to restore well productivity, several discipline and service providers were engaged
   - ○ Petroleum engineering team
   - ○ Field operation team
   - ○ Downhole tools and straddle packer supplier
   - ○ Slick line service providers
   - ○ Electric line service provider

To properly manage the team you have to

- ➢ Listen to all,
- ➢ No idea or view to be considered stupid,
- ➢ All proposals to be discussed
- ➢ The responsibility is not single person it is a team responsibility
- ➢ To ensure having the co-operation among all stakeholder and trying to let everybody within the team feel he is effective.