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A Truly Effective Intervention Cost Reduction Method Using PCP Systems

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Synopsis

One of the major expenses in an OPEX budget for Operator Companies is the well intervention cost. Part of being an Operating Company is dealing with workover intervention activities for any Artificial Lift Systems (ALS). The Operator seeks for the best suitable ALS for their applications to reduce the number of workovers and optimize intervention time. Progressing cavity pumping (PCP) is a preferred method in many fields worldwide due to gas and sand handling capabilities, heavy oil production, low maintenance cost, high overall system efficiency, and lower capital cost compared with most other ALS. In an effort to reduce costs, it is important to consider that the bottom hole assembly typically represents 10-20% of total workover intervention costs. To significantly reduce workover cost, emphasis must be placed on two key elements: intervention duration (time/hours) and rig rate cost (Mobilization + $/hr.). These two elements represent approximately 80% of total intervention cost. Any reduction on these elements will definitely impact the final overall cost.

The new anchor system, allows the Operator to convert any well into an Insertable PCP (I-PCP) without pulling tubing. Normally, interventions would last 2-3 days; however, the workover can be reduced to 0.5-1 day. This tool can be deployed with a smaller rig minimizing the rig cost (Mobilization+ $/hr.) by at least 50%. A reduction of 65% in the time required for the intervention (3 to 1 day) and 50% lower rig rate (smaller rig) resulting in 70-80% savings on the total intervention cost while reducing the well non-productive time.

This paper provides a detailed explanation of this technology, its functionality, well candidate selection, lesson learned and evidence of successful installations with significant cost reductions and additional benefits. Results from field experience globally have shown tremendous cost optimization that favorably changes the whole economic scenario for well interventions. This insertable PCP development can be utilized to reduce the cost of well reactivations, new installations, interim production, well tests, to reposition PC pumps without seating nipples, and to expand PCP systems into applications where PCP was not consider previously. The utilization of this technology has resulted in decreased OPEX for different Operator Companies.

Introduction

This paper presents a new concept on insertable PCP (IPCP) system installations. IPCP anchoring system has been operating in four different regions around the world. The use of this tool has being tested on 3-1/2 and 2-7/8 tubing. It can reduce the installation cost substancially comparing to regular IPCP and conventional PCP methods, also reducing deffered production.

Conventional PC pumps are installed by running the stator assembly on the bottom of the tubing string and rotor on the bottom of the rod string. IPCPs have the entire pump assembly installed on the string and landed inside the tubing string enabling the pump to be pulled and rerun via the rod string however rquieres a pump seating nipple (PSN) initially installed in tubing. The primary advantage of the IPCP anchoring system is the elimination of costly and time consuming tubing pulls to change worn or damaged pumps to install PSN'S. Another potential benefit is avoiding the need to pull and rerun downhole instrumentation.

I-PCP's can be installed in the tubing using two separate methods. The conventional method is through the use of a Pump Seating Nipple (PSN) in the tubing string and corresponding set of seating rings in the pump assembly. This provides a reliable method of landing but requires that the PSN be originally installed and also limits the positioning of the pump to the associated pump seating location; it may also be replaced after several installations due to regular worn. The IPCP anchor allows I-PCP's to be run in wells either not equipped with a PSN or when a conventional PCP is worn or damged.

The IPCP anchor has been tested in many different regions and reservoir characteristics around the world proving to be an acceptable method to expand PCP'S applications.

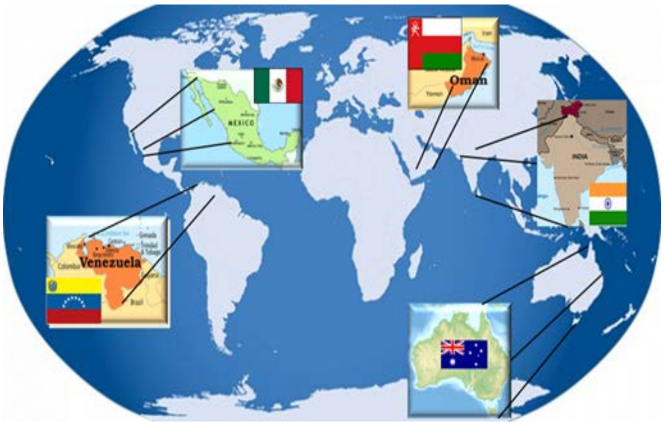

Figure.1 Flexisert Region Installations Worldwide

Body Content

PCP Overview Background

Progressing cavity pumps (PCP’s) are widely accepted; with high production, lift capacity, and system efficiency being a few of the major benefits over other artificial lift systems. PCP’s are comprised of two parts, a helical shaped steel rotor and a stator. The rotor, which is the rotating internal component of the pump, is normally driven by a rod string.

It is precision machined from high strength steel and coated with a wear resistance layer, such as chrome. The stator is attached to the production tubing string and remains stationary during normal operation. It consists of a molded elastomer permanently bonded to the inside of a steel tube. As the PCP operates, cavities are formed between the stator and rotor which move fluid upward in a non-pulsating action from the intake to the discharge of the pump. Pressure builds from the inlet to the discharge of the pump providing the necessary lift to produce fluid to surface.

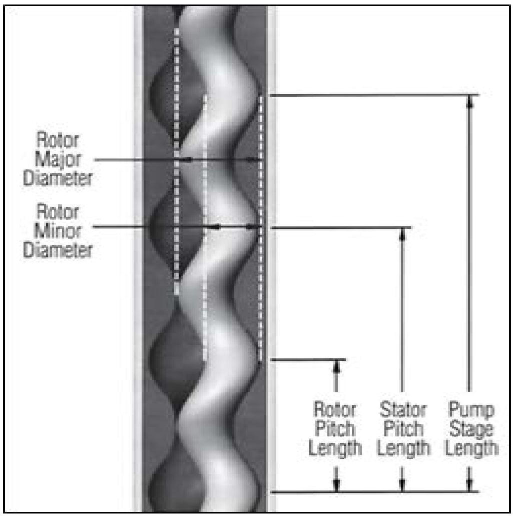

Figure.02 PCP Schematic

Insertable Pump Cavity Progressive

Same operating principle as the conventional tubing conveyed configuration however the complete pump is run into the well on the rod string. The common practice to install an I-PCP system is to first install a tubing string with a corresponding pump seating nipple (PSN) in the tubbing string. The I-PCP assembly is then run downhole via the rod string until the assembly seats in the PSN as shown in fig.03

Figure.03 PSN Down Hole Assembly

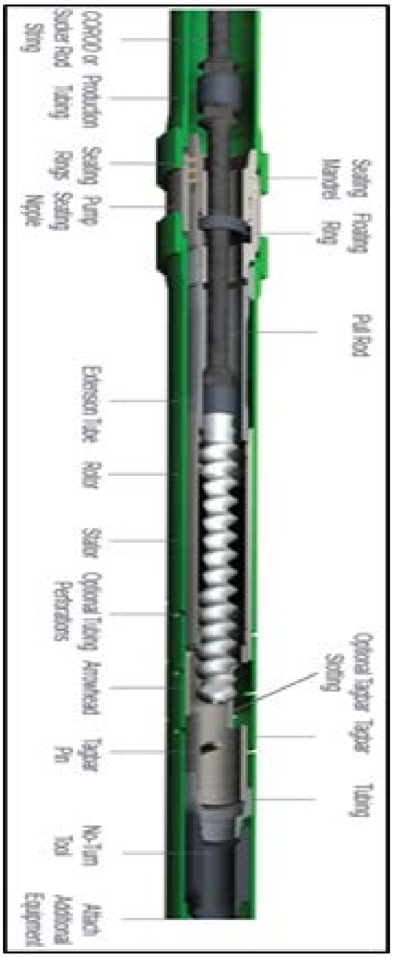

Fig.04 I-PCP Schematic

Insertable PCPs (I-PCP) provide a reduction in well repair and servicing time for pump change costs related to pulling tubing. Once PSN is installed pump changes can occur without having to pull the tubing, reducing servicing costs; after few service installations, eventually can required a PSN replacement depending on well conditions and operation.
An integral no-turn tool feature prevents back-off of pump components.
The PSN and seating rings are located at the top of the assembly, reducing the chance of sand packing in the annular space between the pump and the tubing.
Insertable pumps can be installed in different tubing size as 2-7/8; 3-1/2; 4-1/2 and 5-1/2.

I-PCP Anchor Overwiev
The IPCP anchor allows an IPCP to be run, landed, operated and removed from a tubing string in the absence of a PSN. It provides for a number of functions including preventing rotation, providing a seal between the high pressure discharge end of the pump and the lower wellbore producing pressure and preventing upward and downward movement due to differential pressure across the pump. This technology is currently available for 2 7/8" and 3 ½" production tubing sizes. The tool is able to pass through common tubing restrictions such as pump seating nipples and subsurface safety valves.

The IPCP anchor is connectied to the bottom of the I-PCP as shown in figure 04. The IPCP anchor and IPCP are run into the well on the sucker rod string, lowered to the target position, lifting up to position into the setting position via a J-slot and then setting back down with full rod weight to engage the ratchet ring, slips and bladder. Prior to installation, seating depth position must be selected because the IPCP anchor has been designed to have a one-time set. Once IPCP anchor is set and unset, the tool must be retrieved to surface and redressed. When the IPCP needs to be replaced, the sucker rods are lifted upand the IPCP anchor and IPCP are brought to surface. Unseating force is 5000-6000 lbs for the 2-7/8 configuration and 7000-8000 lbs for 3-1/2 configuration which can be performed using smaller workover rigs or pulling units.

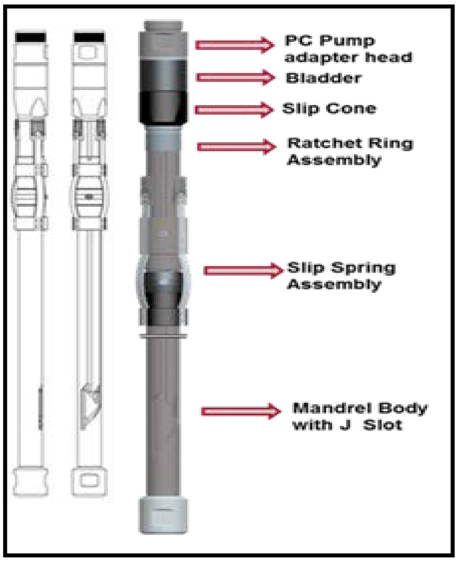

Figure05. Flexiser Anchor Components

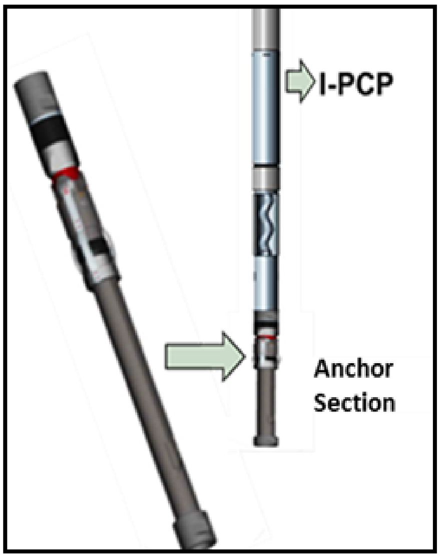

Figure06. IPCP Anchor Tol

Canidate Selection Methodology

Once elastomer compatability test or PCP application has been tested in the field. Any well with 3-1/2 and 2-7/8 tubing configuration where optimization costs wants to be implemented can be considered as candidate in the first screening evaluation.

Then well completion schematic needs to be reviewed for obstacles suchs as restrictions, crossovers or tubing size changes. In older wells where there is a risk of collapsed tubing sections or deformation, drifting the tubing is recommended to avoid the IPCP anchor and IPCP from getting stuck during traveling.

As the IPCP anchor is set by axial load, available rod weight seating force must be reviewed. Rod weight seating force caluculation will depend on rod size (lb/ft) and well deviation. Figure 05 shows seating force calculation for a vertical well. In cases where the seating force is adequate, well completion must be reviewed, evaluating different rod sizes, weight bars or alternately, applying pumping water pressure from surface to apply additional force.

Wells with high sand cut and high intervention frequency, conventional PCP'S can be a better option for long term performace.

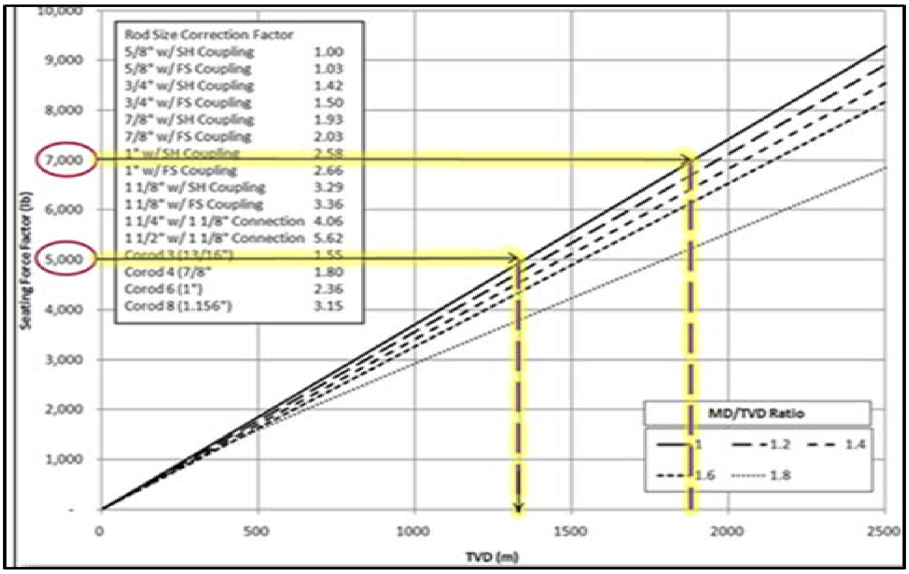

Figure07. IPCP Anchor Seating force Calculations

Once the available setting force has been confirmed and can be met at surface for the required pump landing depth, the IPCP anchor and IPCP are ready to be installed. High deviated wells with angles over 75° are not recommended due to drag forces between the sucker rods and tubing. Filling the tubing with water reducing buoyancy effect is also recommended.

Field development and Installation Results

Labour, contract agreements, environmental regulations, rig availability, well characteristics, weather conditions and access to well location are many variables that can impact workover duration. These apply to all types of PCP installations and installation time can vary from region to region due to different operational conditions.

Regardless operator company, region or any parameter previously mentioned, Chart 08 illustartes when ALS method is replaced to PCP system or cases where PCP system is installed in a free flow well the use of I-PCP anchor minimize 3.5 times (in average) the number of hours intervention comparing with conventional PCP and PSN I-PCP.

Regardless of the operating company, region or any of the parameters previously mentioned, the use of an I-PCP anchor system reduces the intervention time by 67% to 80%, compared to installations on free flow wells or to replace existing ALS method where tubing required pulling.

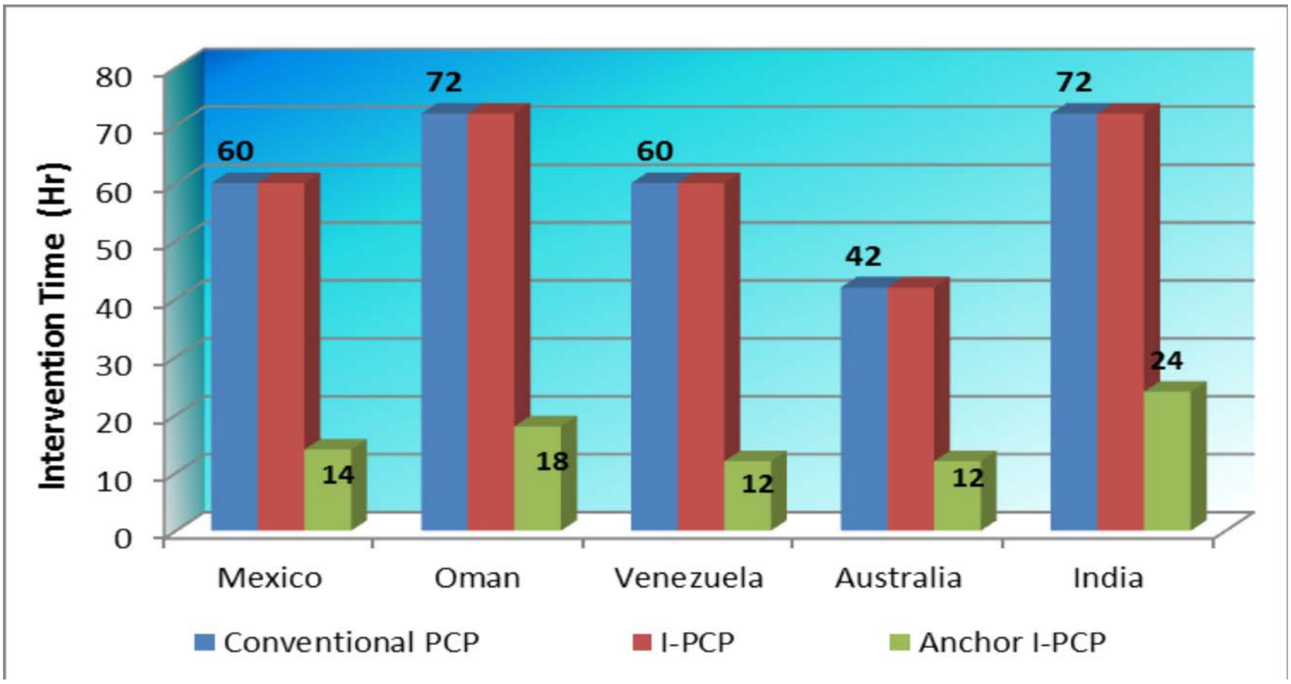

Figure08. First Time PCP System Installation Average Time (Hrs)

An initial IPCP installation, utilizing a PSN and not an anchor, the time and intervention costs are equivalent to a convetional PCP since the tubing must be pulled to run the PSN. Subsequent IPCP installations, incurred the benefit of reduced time associated cost. Time also affect production deffered and operator profits but these parameters become more difficult to present due to different production rates, crude condition (price /barriel), water cut, etc.

The intervention cost on these trials, depend on the particular service contracts each operating company has. As a result, the intervention costs do not necessarily match within a country even between operating companies, however clear savings are achievalble.

Service time is directly related to intervention cost, Figure 09 shows the cost comparison before and after I-PCP anchor intervention; when new PCP and I-PCP system are installed or I-PCP intervention requires PSN replacement.

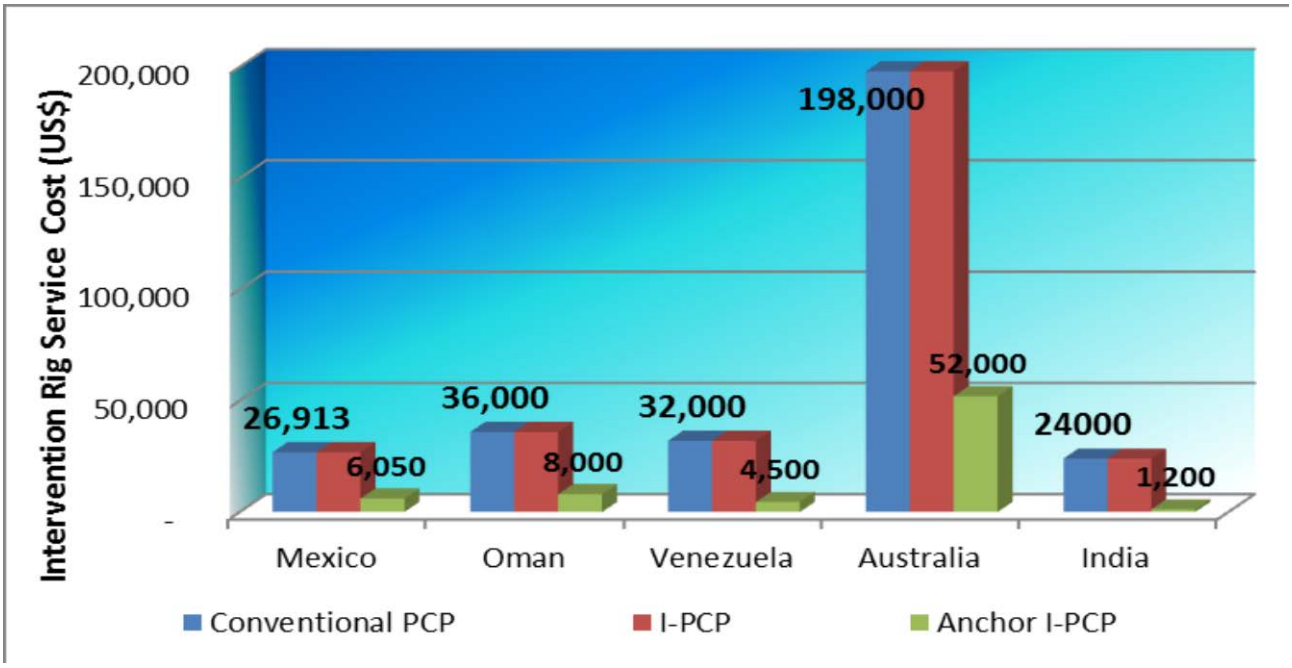

Figure09. First Time PCP System Installation Total Cost ($US)

Figure 09, shows a 75% reduction in service costs for trials done in Australia, 78% in Oman, 86% in Venezuela, 78% for Mexico and 94% in India. As initially mentioned these percentage reductions impact the 80-85% of the total service cost. Saving time and saving cost is not equally proportional in all trials due to regional differences mentioned before.
Once I-PCP system is installed, either using a PSN or an anchor, the PCP replacement cost and time are similar.

For I-PCP systems utilizing a PSN, eventually the tubing may require pulling, for such cases as to lower the I-PCP seating depth (fluid level change), worn PSN, etc. Based on rig rates and historic I-PCP operational performance, Fig10 shows the estimated cost for one well after five PCP interventions for each method (assuming current services cost).
The greater cost difference between I-PCP (PSN) and I-PCP anchor appears on the first installation or anytime PSN needs to be replaced. Fig.10 includes costs for 5 interventions where two of five (2/5) interventions will require pulling tubing.

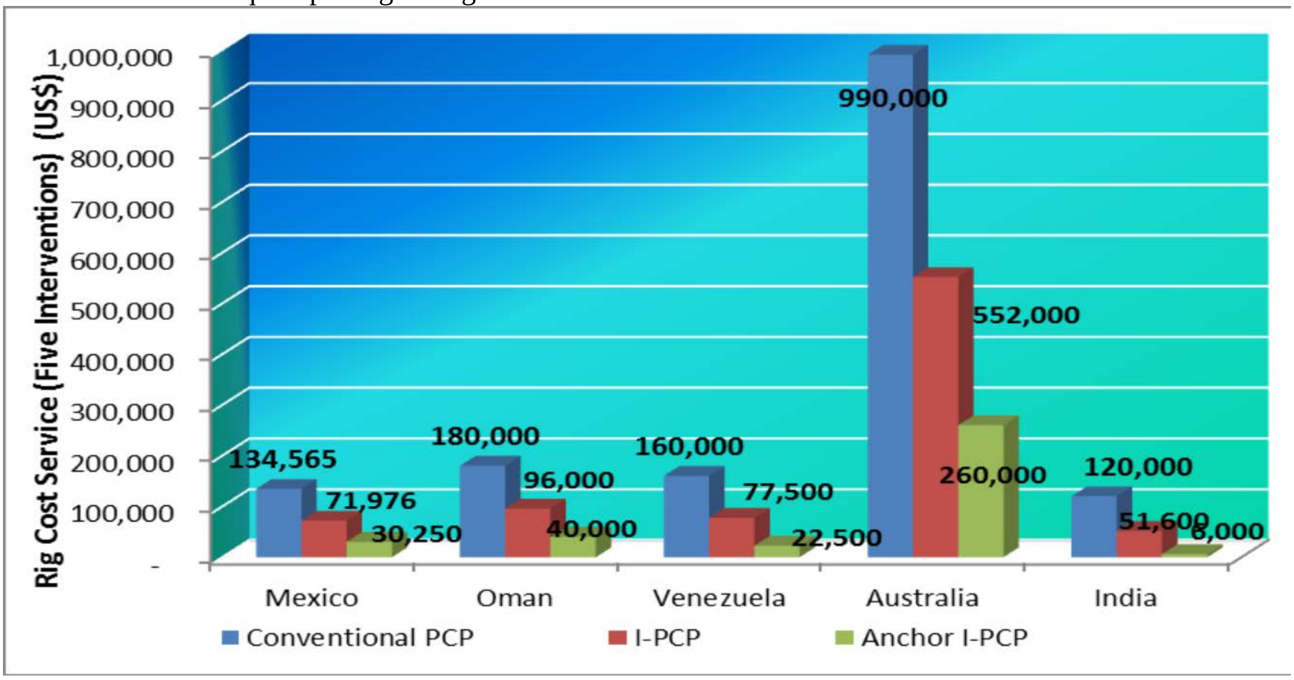

Figure10. Estimated Rig Cost Costs after 5 Interventions in one well

Currently there are 47 IPCP anchors operating in four different continents; 41 wells with 3-1/2 tubbing and 06 wells with 2-7/8 tubing. Only two deviated wells.
The run life of the IPCP anchor will depend on the application conditions, challenges, and scope of the install. Some examples of the IPCP anchor applications are:
- for well reactivation
- monitoring test wells (days-weeks)
- new drill well tests (hour/days),
- validate application for PCP system in the field (mid-term to short-term)
- option to reduce deferred production while waiting for larger PCP system
- long term I-PCP application

The I-PCP anchor applications above, each have a specifc purpose and a different taget run life. As a result an overall average run life is not an adequate calculation to measure performance. Additionally, most of the installations are still running (new technology).
Most of the 47 IPCP anchors that are operating, were recently instlalled. See Figure 11. Two I-PCP anchors are exceeding 2-1/2 year run life and eight anchors with more than 300 days. The trial data confirms the anchor meets customer run life expectations.

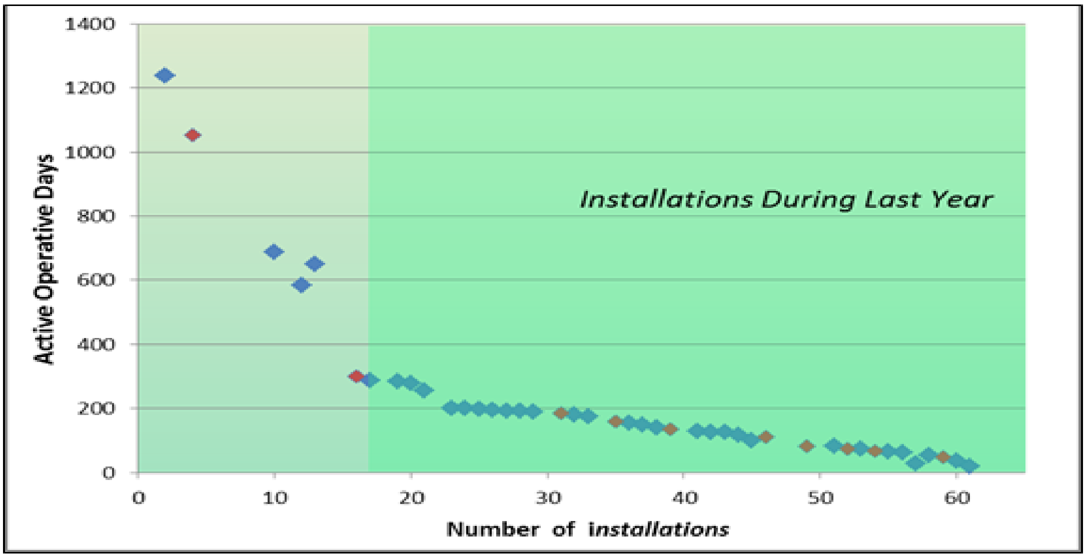

Fig.11 Acumulated run life for active I-PCP Anchor trials

Some of the initial trails were not successful due to incorrect seating depth (exceeding tubing length), incorrect space out, one tool slipped and collapsed tubing (deformity/wear). After the initial learning curve stage, I-PCP anchor has been successfully run and installed in 56 of 62 installations over four different regions.

Figure 12 illustrates seating depths and operating torques worldwide for the 3-1/2-in I-PCP anchor trials. There is a large range in seating depths and it also illustrates the tools are operating below their designed torque rating.
There is no maximum seating depth restriction for the anchor. The rated lift of the I-PCP restricts the depth at which the anchor can be set. However, due to seating force required to set the anchor, there is a minimum depth (depending on well angle deviation). Shallower applications may require heavy weight bars or pumping water from surface to achieve the required load to set the anchor.

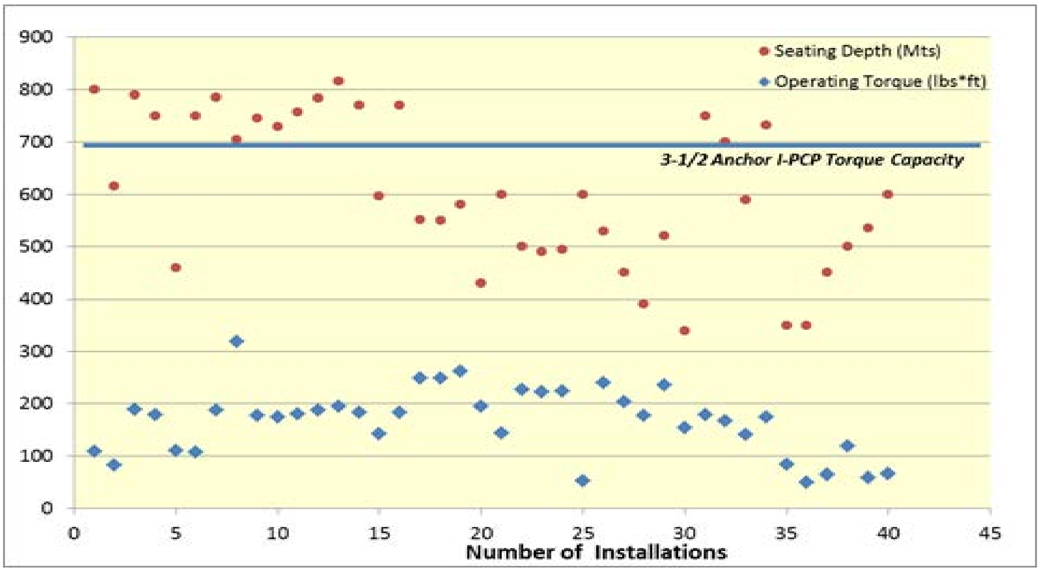

Fig.12 Torque Values and Seating Depths for worldwide 3-1/2-in. successful anchor installation records

Figure 13 below shows the range of seating depths and operating torques for the 2-7/8-in. I-PCP anchor installations worldwide. Most of the operating torques were less than 200 ft*lbs, which is less than haf the rated torque capacity of the anchor (450 ft*lbs). Some seating depths exceed the 3-1/2-in. installations.

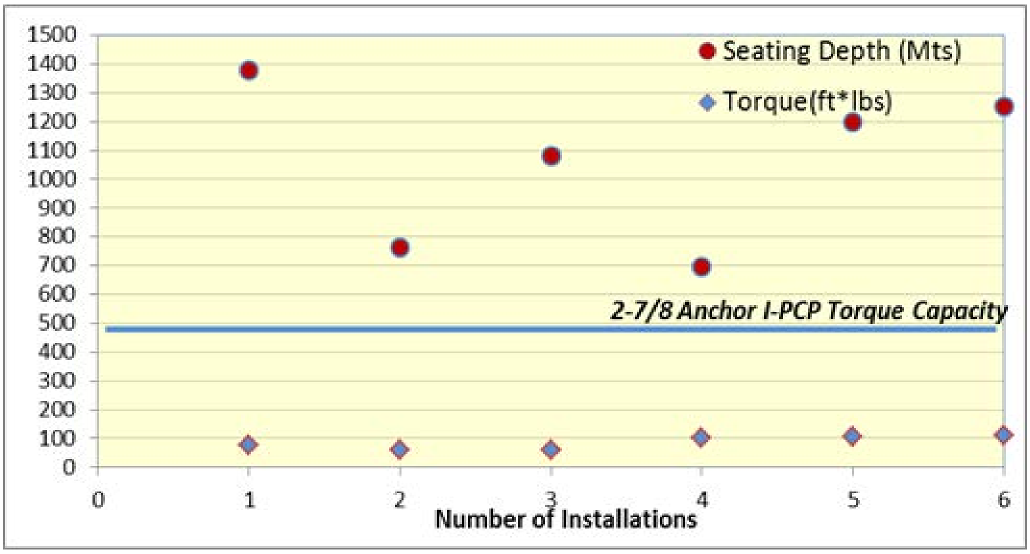

Fig.13 Torque Values and Seating Depths for worldwide 2-7/8-in. successful anchor installation records

Conclusions and Recommendations

The I-PCP anchor allows for installation of an IPCP system without having to install a PSN.

The I-PCP anchor allows operators to use smaller rigs and pulling units to perform installations and interventions.

The I-PCP anchor allows installations to occur with out having to pulling tubing.

The I-PCP installation times with the achor were 20-29% of the rig time and 15-25% of the service rig cost when compared to convential PCP and I-PCP with first time installation of PSN or any PSN replacement.

The I-PCP anchor allows installation of an I-PCP system to perform a well test in one day.

The down times were shorter (by two days in some case) minimizing deffered production, resulting in more cumaltive production by operator company.

Reducing servicing costs drastically, makes low rate wells candidates for interventions. Intervention services will pay back quicker; this benefit also applies for well reactivations which becomes more economic after minimum intervention cost.

As a measure of the the I-PCP anchor performance, a 90% installation success rate was acheiveed after improvements were made in design, training and expertise.

Reducing time and intervention costs not only impacts OPEX, but also impacts deffered production and operator annual budget. The anchor has changed the way a field is operated; having a new economic scenario, where a low downtime results more cumulative production.

The IPCP anchor rated torque is 2 to 3 times more than most of the world wide appplications to date.

Well conditions impact performance of downhole equipment. There are seven I-PCP anchors operating over 1.5 years, demonstrating excellent performance of the seal, material resistance, and torsional/axial anchoring at downhole conditions.

References

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