African Research Review

An International *Multidisciplinary Journal, Ethiopia*
Vol. 8(3), Serial No. 34, July, 2014:108-115
ISSN 1994-9057 (Print) ISSN 2070--0083 (Online)
DOI: http://dx.doi.org/10.4314/afrrev.v8i3.9

Hydraulic Workover Unit (HWU) Application in Down-hole Milling Operations in Niger Delta

Ohia, Nnaemeka
Department of Petroleum Engineering,
School of Engineering and Engineering Technology (SEET),
Federal University of Technology, Owerri, Nigeria
P.M.B. 1526, Owerri – Nigeria
E-mail: princepetra@yahoo.com

Anyadiegwu, Charley
Department of Petroleum Engineering,
School of Engineering and Engineering Technology (SEET),
Federal University of Technology, Owerri, Nigeria
P.M.B. 1526, Owerri – Nigeria

&

Ukwujiagu, **Chinedu**
Department of Petroleum Engineering,
School of Engineering and Engineering Technology (SEET),
Federal University of Technology, Owerri, Nigeria
P.M.B. 1526, Owerri – Nigeria

Abstract

The major challenge with down hole milling operations using HWU is employing a suitable fluid circulating system, which is very critical for effective well bore cleaning and transporting of cuttings from the well bore to the surface. A bell nipple with

sufficient side outlet diameter to ensure efficient fluid circulating system was designed and installed above the top of the BOP stack. During the HWU rig up, the height of the unit was kept as low as possible to ensure unit stability during operation, without further increasing the height of the unit and reducing its stability. Furthermore, HWU being directly rigged up on top of BOP stack, did not require the bell nipple to be a load bearing spool to support the weight of the unit and the work string when fully rigged up and operational. This paper reviews the application of Hydraulic Work over Unit in down hole milling operation in Niger Delta highlighting the steps taken to ensure good circulating system without compromising the unit stability, and eliminating additional cost of load bearing bell nipple/spool.

Key words: HWU; Milling; Cement retainers; Cement plug; Workover; Bell Nipple; Wellbore clean-up

Introduction

Down hole milling ranging from cement drill out to packer milling is a common operation during well work over/re-entering using conventional work over rigs but not the same with Hydraulic Work over Unit particularly in Niger Delta. When the Hydraulic Work over Unit (HWU) was introduced in Nigerian Oil and Gas Industry in 2001, its initial work scope was basically to retrieve old complet1ion string and run new completion assemblies on wells of about 6000 ft. A further step saw the unit being utilized for casing cutting and retrieval in well abandonments. As the unit moved from well to well, experience and expertise were gained and the scope of work continued to expand. The capabilities of Hydraulic Work over Unit were proven as new areas of application were developed and executed. Within the space of four years, the use of HWU in well operations has moved from the simple tubing retrieval and re-completion to complex fishing/milling operations in wells as deep as 13,000 ft.

Over the past four years, Hydraulic Work over Unit (HWU) has continued to gain interest among operators in the upstream oil and gas sector in Nigeria. Its popularity as alternative means of carrying out well work over, re-completion and well abandonment other than the conventional rig has increased tremendously because of its overall cost effectiveness. Within the first four years of its operation in Niger Delta, the initial scepticism that trailed its introduction as a work over rig fizzled away. However, what was still in doubt was its ability to carry out milling operations such as cement drill out and packer milling which are often encountered in the course of well work over/re-completion.

Indexed AJOL: www.ajo.info

This aspect of well operation posed a great challenge and presented another mile stone for Hydraulic Work over Unit in Niger Delta.

Materials and methods

Candidate wells and pre-job planning

Two wells of approximately the same depth were programmed for work over and re-completion using HWU in the south east of the Niger Delta. Apart from the usual operation of retrieving old completion tubing and running new ones which HWU has proven to be very efficient, the work scope for these two wells involved milling permanent packers and drilling out cement plugs and retainer. These milling operations posed a great challenge to HWU operation. Because these operations were hitherto new in the Nigerian Oil and Gas industry with HWU, there were scepticisms about achieving a good result. Therefore, the only way of proving the unit's capability in terms of milling operation was to put it on trial.

In planning for the job the following were identified and taken into consideration

1. Drilling fluid circulating system
2. Bottom hole assembly (BHA) selection and handling
3. Torque and rotary speed requirements

Of all the three items identified, drilling fluid handling and circulation posed the greatest challenge. The major area of concern in fluid circulation was the fluid return system. Unlike a conventional work over rig, where the bell nipple is mounted on top of the annular preventer and the returning drilling/work over fluid routed through the bell nipple outlet to the shaker via a return line and then to the fluid return tank. This is not the case with HWU because the unit is rigged up directly on top of annular preventer without bell nipple. Fluid circulation is achieved through one of the BOP side outlet valves with annular preventer closed. During milling or cement drill out operation, cuttings are expected on the surface which required a higher pump rate & annular velocity to carry them to the surface and larger side outlet other than 2 – 3 inches diameter of 5M BOP side outlets for the returning fluid. The use of a bell nipple with up to 7-8 inches inside diameter was considered as an alternative which raised another concern on how and where to install it. Installing the bell nipple on top of the annular preventer as obtained in a conventional rig was considered inappropriate for the two reasons

Firstly, it will increase the overall height of the unit.

Secondly and more critical, bell nipple was not considered strong enough to bear the load exerted by the unit plus the string weight during operation. This became a

problem that must be tackled to ensure good well bore cleaning during milling operation.

The maximum rotary torque of the unit is 6,600 lb-ft and speed of about 60 rpm. These were considered adequate for the job. However, a down hole mud motor was to serve as contingency. No problem was envisaged on BHA handling for milling since the unit has a good record on other down hole fishing operation.

Results

Equipment rig-up and milling operations

In addition to the usual HWU rig up procedure, a bell nipple was designed, fabricated and installed at the work window mounted on top of the annular preventer. A third party inspection was carried out on the bell-nipple before installation the inspectors reviewed each weld, the welders and welding procedures used. This was done shortly after completion of the welding/fabrication job, but not within 24 hours.

The HWU bell nipple consisted of:-

Large bore nipple sized to sit in bore of access window.

- ✓ Hold down bolts and nuts.
- ✓ Rubber gasket seals.
- ✓ Flow line side outlet.
- ✓ Access window connector plate.

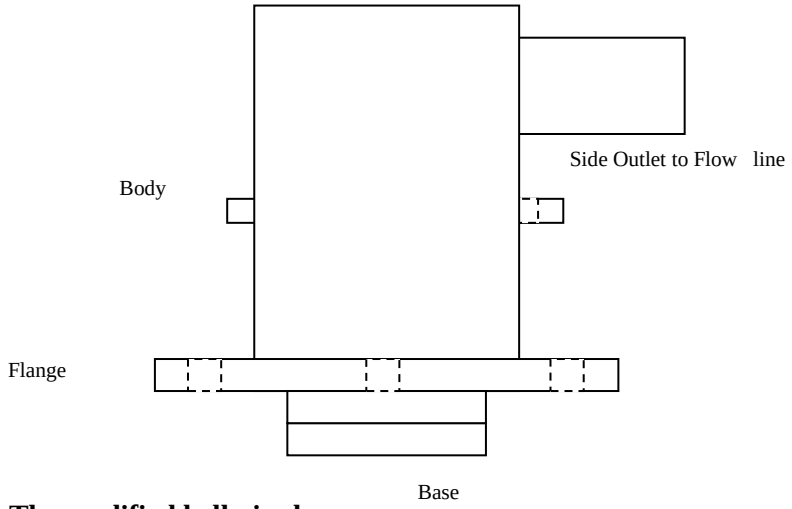

Figure 1: The modified bell nipple

A 7'' diameter flow line connecting the bell nipple side outlet to the flow back tank. This is to ensure effective fluid circulating system without damaging the annular element or allowing the fluid to over flow on the work window. The BHA was selected and ran as required by the program of operations (i.e. packer milling or cement plug and retainer drill out). With the maximum rotary torque of 5000 ft-lb and speed of 40 rpm, the unit was able to mill permanent packer drill out cement plug and retainer successfully with sufficient cuttings brought to return tank via the bell nipple, thereby achieving another milestone in its operation in Niger Delta.

The Modified Bell Nipple Specification

Body: 1. OD: 13.38" 2. Wall thickness: 0.33" 3. ID: 12.715" 4. Steel grade: J-55 5. Collapse Resistance: 1130psi 6. Weight: 48ppf 7. Height: 10ft	Flange: 1. Nominal flange size: 12 2. OD of flange: 17-1/2" 3. Flange thickness: 1-3/16" 4. No of bolts: 8 5. Size of bolts: 5/8" 6. Length of bolts: 4-1/2"
Base: 1. OD: 10.75" 2. Weight: 40.5ppf 3. Thickness: 0.35" 4. I.D: 10.050" 5. Steel grade: J-55 6. Collapse Resistance: 1580psi	Hose assembly specs: 1. Size: 8" suction hose 2. WP: 500psi 3. Coupling: 8" double-bolt clamps 4. WT (working temperature): -40°F to 212°F 5. Cover: Black, oil and abrasive resistant synthetic rubber 6. Reinforcement: Textile reinforcement with Helix wire

Discussion of results

An effective well bore clean-up operation (during the milling job) was successfully achieved because of addition of the modified bell nipple to the HWU rig-up.

With a completion brine of 10.00ppg (74.8Ibs/ft3 or 1.198kg/l) and a viscosity of 0.51cp 210degF, while pumping 50bbls of intermittent Hi-vis pill, a consistent and successful milling operations through a cement plug and retainer in both wells under review was achieved.

In a 9-5/8"; 53Ibs/ft; N-80 production casing and milling with a 3-1/2" IF (NC-38) drill pipe and pumping at a steady rate of 400gpm (10bls/min) we were able to sustained a calculated annular velocity of 163ft/min and a Reynold's number of 2.5 x 10^5 This turbulent flow significantly improved the debris - carrying capacity of the completion brine as the borehole was circulated clean during the milling operation.

Conclusion and recommendations

With the successful development and installation of this bell nipple in the access window area of the HWU, without compromising the stability and safety of the equipment and personnel, a good circulation system to transport cuttings to surface was successfully achieved at a significantly reduced cost when compared to performing the same operation with a conventional drilling rig. This simple innovation was now broadened the scope of work and application available to the HWU in the Niger Delta Region and is recommended for milling operations within the limits of the HWU applications.

Acknowledgements

Special thanks to the Management of Hydraulic Solutions Limited for granting me the permission to produce this paper; acknowledging also is the contributions of the entire design and fabrication team.

References

Brown, J. (1977). Application of Hydraulic Workover Units to North Sea Operations. SPE 6687-MS, presented at the Offshore Europe Conference, September 14-15, 1977.

Odita, C., Adenikpekun, A., Wakama, M., Ahire, D., & Ojo, J. (2004). Abandonments of Wells in Shell Nigeria Operations SPE 88921, presented at 28th Annual SPE International Technical Conference and Exhibition in Abuja, Nigeria, August 2-4,

[illegible] Experience of Using Hydraulic Workover Unit (HWU) for Re-entry and Drilling Operations Onshore Gabon. SPE 97373-MS, presented at the SPE/IADC Middle East Drilling Technology Conference and Exhibition, September 12-15, 2005

Maddox, S. (1994). Hydraulic Workover Techniques: Their Versatility and Applications. SPE 27605, presented at the European Production Operations Conference and Exhibition held in Aberdeen U.K, 15-17, March 1994.

Weatherl, M. & Hardy, J. (2001) A New Approach to Side Track Drilling of Marginal Wells Offshore SPE/IADC 67827, presented at the SPE/IADC Drilling Conference held in Amsterdam, The Netherlands, 27th February – 1 March 2001.

Hijlkema, S. (2002). Rigless Activities at Otumara in the Western Nigerian Swamp. SPE 79550, presented at the 26th Annual SPE International Technical Conference and Exhibition in Abuja, Nigeria, August 5-7, 2002.

APPENDIX A:

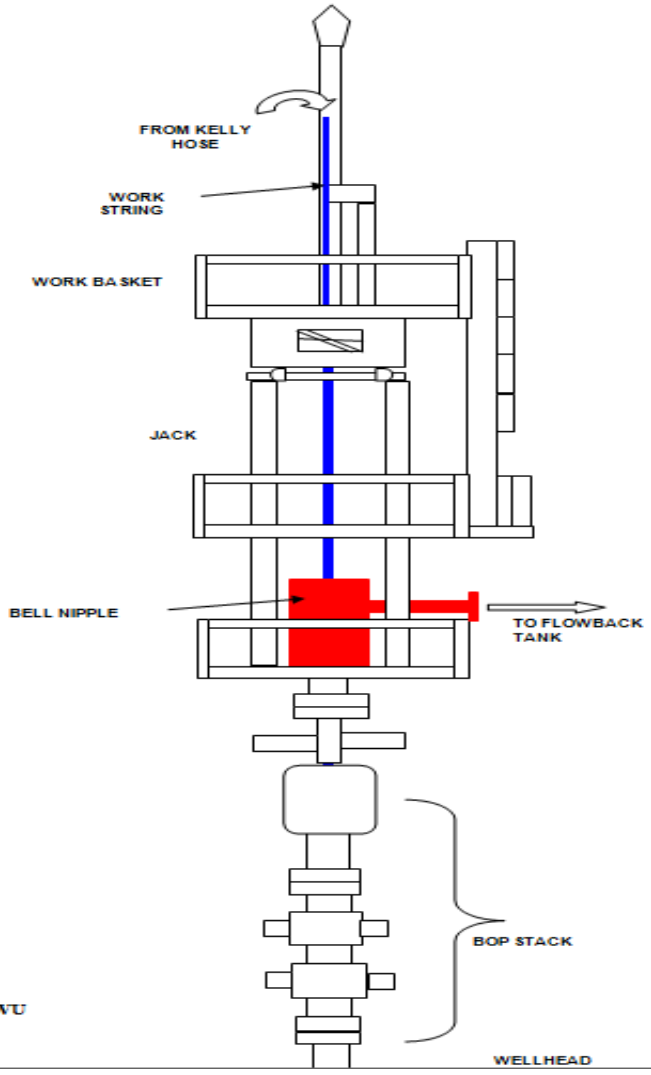

Figure 2: Bell Nipple on HWU

APPENDIX B:

Table 1.0: Potential Hazards Analysis

Sequence of Basic Steps	**Potential Accidents or Hazards**	**Recommendation to Eliminate/Reduce/ Mitigate Hazards**	**Responsible Person(s)**
Fabrication/ welding of bell nipple	Contact with hot surfaces/heated metal or fire. Noise	Ensure proper PPE is worn and that objects being welded are stable and adequately supported. Hot work permits must be enforced. Follow safe work practices and procedures.	Welders/fitters foreman
Installation of fabricated bell-nipple	Lifting/striking against object or by object. Being caught (sandwiched) in between objects. Generating sparks when hammering the bolts & nuts in place	Observe all safety precaution associated with lifting operations (use taglines, standard signals, etc.). Operate in a safe and controlled condition and also within environmental limits. Only a dedicated banks man should give crane signals. Use hydraulic torque wrenches to torque the bolts & nuts and avoid hammering.	Crane Operators & Supervisors/banks man.
Fluid pumping and circulation	Leaks/leakages and spills. Contact with brine can cause skin or eye irritation. Loss of primary pressure containment.	Provide eye goggles or face shields as required. Fresh water eye-wash stations must be available on site. Make sure rubber gaskets are properly placed and bell-nipple bolts tightly fastened. Ensure circulation is at appropriate and recommended flow rates. Ensure that bell-nipple height is not below 6ft. Ensure proper line-up from the pump to the well, and watch/observe your pressure gauge always while pumping.	Pump operator/Supervisor(s)