Milling / Underreaming Case Histories

Date: February 2008
Job Objective:
During a Workover and whilst trying to recover a lower completion, the PBR latching tool was backed off at the wrong connection in the snap-latch. This left a 3" bore with a 1" wide x 1-1/2" Long x 3/16" thick key in the top bore. This prevented any subsequent latching with an internal spear. It was decided to mobilize a milling BHA to mill out the key and enable retrieval of the lower completion.
Job Outcome:
The following BHA was run on 3-1/2" drill pipe inside the 7" Casing:
Cross over back to work string,

- 2-7/8" OD Motor head assembly,
- 5-3/4" non rotating centralizer,
- 2-7/8" WellDrill motor,
- 5-3/4" non rotating centralizer,
- 2.98" OD taper mill.

The BHA was then run in hole breaking circulation every 20 stands. Weight and pumping parameters were established at 14,850'. The BHA was then lowered until the obstruction was tagged and the work string was flagged. The work string was then pulled back 10' and the pump rate was brought up to 120GPM; time was given for circulation rates and pressures to stabilize. The string was then lowered again until the flag depth was almost at the rotary table and a pressure increase of 100psi was noted. Time was given for the mill to bed in before continuing in hole. After 2" of progress the circulating pressure dropped off back to off-bottom pressures (circa 20 minutes). The string was then lowered a further 18" to allow the 5-3/4" non rotating centralizer to bottom out on top of the PBR. Weight was applied to confirm tag without stalling-out the motor. BHA was then recovered to surface where there were excellent indications of the key being milled. An internal spear was then run into the top of the PBR snap-latch and the lower completion was then jarred free and recovered to surface.

Date: October 2007
Job Objective:
To reopen the well to expose the perforations below a Cast Iron Bridge Plug for gas injection.
The client had previously made an attempt to clean out the well using one of Welltonic's competitors, a total of 15 days was spent trying to mill out the debris and the CIBP – but it was decided to abort the operation as no progress had been made.
Job Outcome:
Welltonic submitted a proposed programme to the client and were awarded the operation with the preferred coiled tubing vendor, at this point all the specialist mills and equipment were manufactured and sent to location.
The operation took a total of 8 days and involved 14 separate coiled tubing runs as detailed below.

- 5 Venturi runs, each of which had junk retrieved from the hole.
- 8 Motorized venturi runs, each of which had junk retrieved from the hole, the last of which retrieved some parts of the Plug.
- 1 milling run utilizing a 2-7/8" WellDrill Motor in conjunction with a Hurricane Mill. The Bridge Plug was successfully milled after 1.5 hours and pushed below the perforations to enable Gas Injection to commence.

Date: May 2007
Job Objective:
To mill Out 2 x I-BOP's and 1 x Filter Screen in stuck drill-pipe with a possible 8,100 psi in the tubing to allow access to perforate the tubing to enable circulation to kill the well and restore drilling operations.
Job Outcome:
A taper mill was run in conjunction with a 2-1/8" WellDrill Motor. The first IBOP was milled out in short time. The tools were taken back to surface to check the condition of the mill, these were then re-run and the second IBOP milled out and tools rechecked.
The Filter Screen was then milled out and BHA changed to a Jetting BHA to go back in hole and circulate Heavy Mud to maximum depth to enable perforating.
All objectives were achieved to the companies requirements.

Date: April 2007
Job Objective:
To mill out a Wireline Centralizer Arm that had been lost in hole and was blocking access to liner. This would then allow full wellbore access to enable further perforating.
Job Outcome:
A 3.70" Aardvark Mill was run in conjunction with a 2-1/8" WellDrill Motor to mill away the obstruction. After several initial stalls getting a purchase on the obstruction, it was milled away and full access was restored to enable further perforating which resulted in a further 3,000bopd production.

Date: April 2007
Job Objective:
To mill out cement after a Water Isolation job and allow full access to enable further perforating.
Job Outcome:
A 3.70" Aardvark Mill was run in conjunction with a 2-1/8" WellDrill Motor to mill away the cement. After some light milling, full access was restored to enable further perforating.

Date: February 2007
Job Objective:
To mill out an unknown restriction below the wellhead and retrieve a SSSV which had been in the well for 20 years.
Job Outcome:
A 3.875" Taper Mill was run in conjunction with a 2-3/8" Motor to mill through the obstruction. The obstruction was milled and the well was drifted to ensure sufficient bore for the retrieval of the SSSV. The SSSV was retrieved with a GS run in conjunction with an Impact Hammer and Accelerator. This then allowed the well to be killed in preparation for a workover.

Date: January 2007
Job Objective:
To mill out a Composite Bridge Plug and return the well to production.
Job Outcome:
The composite bridge plug was successfully milled out utilizing a 2-3/8" Motor and a 3-1/2" FB Chomp Mill in conjunction with 1-1/2" CT. Milling time was less than 2 hours. A ball was then pumped to the circ sub to enable the well to be kicked off with N2.

Date: December 2006
Job Objective:
To mill out a Composite Bridge Plug.
Job Outcome:
The composite bridge plug was successfully milled out utilizing a 2-3/8" Motor and a 3-1/2" FB Chomp Mill in conjunction with 1-1/2" CT. Milling time was less than 2 hours.

Date: November 2006
Job Objective:
To mill out a mixture of Barium Sulphate, Calcium Carbonate, Strontium Sulphate and Zinc Sulphide scales from the Tubing Hanger to TD at circa 22,300ft to enable further Intervention and to restore production.
Job Outcome:
Initially it was impossible to pass through the surface tree, so this was chemically soaked and jetted with a rotating pulse tool. A 4.75" Taper PDC mill was then run and successfully milled the scale down to the DHSV. A range of 4.50", 3.75" and 3.50" Taper PDC Mills were then run to mill the various scales concentrically down the tubing. A 3.125" Under Reamer with suitable blades was then run to ensure the liner was cleaned to TD. All runs were completed successfully with no incidents or down time.

Date: October 2006
Job Objective:
To mill out Calcium Sulphate Scale in order for a Plug to be set in the tubing to enable further investigation.
Job Outcome:
A 4.125" PDC Mill was run in conjunction with 2-7/8" PDM and successfully milled the scale to below Plug setting depth.

Date: September 2006
Job Objective:
To clean out drilling related solids from the wellbore to allow the well to be used as a Water Injector
Job Outcome:
A 3-1/2" Junk Mill was run in conjunction with a 2-1/8" PDM and successfully removed the debris from the well, after a successful Injection Test the well was put on full Water Injection.

Date: July 2006
Job Objective:
To remove Barium Sulphate Scale from two subsea wells and bring the wells back into production.
Job Outcome:
Both wells were successfully completed with all scale removed with Taper PDC Mills.

Date: May 2006
Job Objective:
To remove scale from above the DHSV to allow it to be changed out.
Job Outcome:
An acid jetting run was initially performed to remove most of the Calcium Carbonate Scale from the Surface Tree down to the DHSV. A 6.00" Hurricane Mill was then run in conjunction with a 3-3/8" PDM to ensure the wellbore was clean. The DHSV was then pulled on Coiled Tubing to allow the workscope to continue.

Date: May 2006
Job Objective:
To open a Formation Isolation Valve to allow the well to produce after completion.
Job Outcome:
After initially attempting to open the valve with the FIV Shifting Tool, the valve was still closed. Welltonic manufactured a mill to open up the ball to drift ID. The Valve was milled out successfully and the well was then put on production.

Date: May 2006
Job Objective:
To mill out an Incoloy 925 alloy Flapper that had become detached from the TRSSSV to restore wellbore access.
Job Outcome:
The flapper required to be milled as it was too large to retrieve from the wellbore by Fishing methods. After extensive research and consulting several specialist companies who machine Incoloy 925 regularly, Welltonic found that standard mills would not be suitable for this material as they would work harden the face of the material and make it virtually impossible to mill or machine. Welltonic got suitable burning shoes manufactured and dressed with a diamond grit composite material. The shoes were run in conjunction with a 2-7/8" PDM and the flapper was successfully milled allowing the centre section to be retrieved to surface.

Date: March 2006
Job Objective:
To mill out an obstruction to enable Stiffline logging operations to assess if further production could be added.
Job Outcome:
The obstruction was found to be Barium Sulphate Scale, this was successfully removed and the well was then logged on Stiffline, the resultant log showed an area of further oil which was perforated on Stiffline and resulted in a substantial gain in production.

Date: January 2006
Job Objective:
To mill out a hard scale to allow e-line access to perform a soft punch in the production tubing to enable a well kill.
Job Outcome:
A 3.791" OD PDC Taper mill was run in conjunction with a 2-7/8 motor inside 4-1/2" tubing to clean out hard scale, (type unknown) to TD at 12,370'.
The scale was first encountered at 8,520' Milling commenced at 1.8BM with brine and milling was completed in 25 hours with a total depth milled of 3,850'. The well was then circulated bottoms up. E-line was then able to enter the well and soft punch a hole in the tubing, to circulate the annulus before a work over could commence.

Date: January 2006
Job Objective:
To mill out a Formation Packer Shoe and Collar and allow full access to the formation below.
Job Outcome:
A 3.75" Flat Bottomed Junk Mill was run in conjunction with a 2-7/8" Motor. The assembly was RIH to depth and milling commenced. After milling through the Shoe and Collar the assembly was run to TD to ensure access.

Date: December 2005
Job Objective:
To remove Scale in the 5 ½" Tubing to enable the setting of a packer.
Job Outcome:
A 2-7/8" Under-reamer dressed with 4.892" Blades was run in conjunction with a 2-7/8" Motor. The assembly was RIH to depth and Reaming commenced. Due to issues with handling returns ROP was limited to 20 ft / hr. After each 20 ft section the tubing was back-reamed an extra 10 ft. This continued until the target depth was achieved (circa 420 ft section). The whole 420 ft section was then back-reamed to ensure full drift and hole cleanliness.

Date: November 2005
Job Objective:
To mill out an FIV (Formation Isolation Valve) to enable the well to flow, allow full access to the well and cleanout to TD.
Job Outcome:
A 4.094" OD Milling BHA was ran in hole to 13,227ft at which point circulation was started at 2.8bbl/min. The annulus pressure was choked back by an auxiliary surface well-test unit to maintain a constant bottom hole pressure of 8800psi which provided 500psi differential across the FIV. Milling commenced with a differential of 300-500psi on the motor, after approx 1hr of milling, gas was observed at the surface choke which indicated that there was communication across/through the FIV. At this point it was difficult to determine how effectively the motor was operating due to the annulus pressure fluctuating due to the slugging affect of gas / fluid passing through the choke. Milling continued for a further 1 hr at which point there was no apparent differential across the motor. The FIV was then drifted 3 times with the 4.00" OD Stabilizer to confirm full access through the valve, after which the tools were run to TD to cleanout and displace any remaining drilling fluids to Base Oil. The mill was inspected at surface and showed signs of uniform wear with a few chipped cutting inserts.

Date: December 2004/ January 2005
Job Objective:
A new upper completion was run, however a junk catcher had been installed in a crossover below this and the fishneck was too large to pass through components within the upper completion. The objective of the operation was to recover the junk catcher without damaging the upper completion and without jeopardizing the future integrity of the well.
Extensive testing took place and by means of an offset shoe with centralizing probe, on a high-speed motor, the fishneck was milled from the junk catcher in order for it to pass through the crossover on to a plug below. During the milling however it was discovered that the junk catcher extensions had a tendency to back off and this made milling the fishneck nigh on impossible.
To overcome this problem a unique and innovative 'lockout assembly' was built whereby a wicker thread stabbed into the fishneck on the junk catcher with extensions below this ensuring that a spear was positioned within the lower section. This ensured that if the extensions started to back off the spear would engage and prevent the extension pieces from falling off.
Other significant benefits of this assembly were that a centraliser was included for the shoe to ride over, which resulted in far greater centralisation and also removed the requirement for the probe in the shoe. As well as this a standard fishneck was fitted above the stabiliser to significantly simplify the subsequent fishing operation after milling the fishneck.

With this new technology available and the programme in place for the new methodology further testing was performed and the plans were put in place for the actual operation offshore. The job was planned for 3 runs as follows:

- Run lockout assembly on wireline as per the dummy.
- Mill fishneck with offset shoe and high-speed motor so that junk catcher passes through crossover.
- Recover junk catcher assembly with lockout assembly attached using Flow Release JDC Pulling Tool.

The testing was a major success and the further lessons learned were implemented when planning the actual operation. This involved an additional run prior to running the lockout assembly in order to ensure the junk catcher was empty and the spear could reach the lower extension and the wicker stabbed into the fishneck. Also the Flow Release JDC Pulling Tool was modified with a skirt to simplify the fishing operation.

Job Outcome:

The job was a major success and in addition to the 4 planned coiled tubing runs another 4 were made in order to recover plugs and prongs below the junk catcher as they could not be pulled on slickline:

- Successfully ran dummy lockout assembly (no grapple on spear) on wireline to ensure spear located in lower extension and wicker stabbed into fishneck.
- Successfully ran lockout assembly on wireline as per the dummy.
- Successfully milled fishneck with offset shoe and high-speed motor so that junk catcher passed through crossover and landed on plug below.
- Successfully recover junk catcher assembly with lockout assembly attached using modified Flow Release JDC Pulling Tool.
- Successfully recovered 2 x Plugs a 2 x Prongs from below the crossover that held the junk catcher.

This job was hailed as a massive success by all involved and was very important in terms of increasing the production of the field. The job introduced new and groundbreaking technology and prevented a workover or sidetrack having to be performed at substantial cost to the operator.

Date: September 2004
Job Objective:
The well had Two 7.00" Casing Monolock plugs set in it at 370ft – The Lower Plug although set was not holding pressure – subsequently a second Plug was set above but was pulled apart at the Slip assembly Leaving the lower Inner and Outer slip assembly engaged in the Tubing.
The object was to mill over and recover the upper Plug and then retrieve the lower Plug to gain wellbore access.
Pre Job meetings and surface tests concluded that Cement would be placed on the upper plug prior to milling – surface tests Proved to Client that Job objective was achievable using 2.00" CT as Workstring to perform all Operations.
Job Outcome:
After Cement was spotted a Cleanup to Top of plug was performed – A 5-3/4" Dia Washover assembly was Run to mill the upper plug slips and slip cone assy Plug was tagged at 369ft approximately.
Total milling Time approx 44hrs (similar to Surface Trial) in which 11.00" Of Slip and Slip cone was milled successfully.
Subsequent cleanup runs with washtool and Acid prepared Fish for retrieval with flow release spear on coiled tubing. Remainder of Fish recovered first attempt.
Lower plug was then recovered again using Coiled Tubing and Flow release GS pulling tool at first attempt.
Total milling and retrieval time for both plugs 5 days.

Date: August 2004
Job Objective:
To mill out Flapper Valve from 2-7/8" Downhole Safety Valve using 1-1/2" Coiled Tubing.
Job Outcome:
Tagged Flapper at 1,401ft with 2-1/8" Motor and 2.252" Round Nosed Tungsten Carbide Dressed Mill.
Start Milling, Pumping at 1bbl/ min at 19.00hrs at 00.20 hrs next day had milled through Flapper.
Total Time milling 5hrs 20 mins.
Run Clean-up Assembly, Taper and String Mill – Job Complete.

Date: April 2004
Job Objective:
To mill out/ retrieve Wireline Permanent Set Bridge Plug from 2-7/8" Tubing at 2,113 meters.
Job Outcome:
Commence milling on Plug – Partial Recovery of setting Mandrel.
Continue milling – Remainder of Plug milled and pushed to 2,775.6 meters.
Client decided this was sufficient depth for reperforating.

Date: July 2003
Job Objective:
To mill out over displacement of cement from 4.00" Liner using 1-3/4" Coiled Tubing.
Job Outcome:
Cement was tagged at 10,871ft using 2 3/8" 5/6 5.2 stage Motor and 3.00" Tungsten Carbide Mill.
Milled to a depth of 10,938 ft required target depth in 6hrs milling time pumping 1.15bbl/min –
Averaging 11 ft /hr with no problems.

Date: June 2003
Job Objective:
To mill out an extreme build-up of hard scale inside a 3-1/2" Completion, including 30 joints of Heavy Weight Drillpipe, and 5" Liner using 1-1/4" coiled tubing. This well was highly deviated and scale was present from 2,600 metres to 2,906 metres, at the lower perforated interval, which was particularly badly affected by scale build-up. The objective was to increase production by re-perforating after the scale removal operation.
Job Outcome:
Milling proved to be particularly hard and eventually the motor and mill required to be changed out due to repeated motor stalls. On changing to a tapered diamond mill greater ROP 's were achieved and the required depth of 2,906 metres was reached. This allowed access for a gauge run on wireline and the well was then successfully re-perforated. The average ROP using the tapered mill was well in excess of any previous milling attempts in this particular well and the customer acknowledged this fact.

Date: March 2003
Job Objective:
To mill out an extreme build-up of hard scale inside 3 ½" Tubing and 5" Liner using 1 ¼" coiled tubing, from a depth of 1,401 metres to the lower perforated zone at 2,800 metres. This lower zone was producing a high percentage of water and it was intended to re-perforate the well at a higher zone in order to increase production.
Job Outcome:
Excellent ROP 's were achieved in removing the scale with purpose built diamond mills and the increase in production was such that there was no requirement to re-perforate the well after the scale was removed. On one run, lasting 37 hours, almost 1,200 metres of cement was removed, giving a very impressive average ROP of over 32 metres per hour.

Date: September 2002
Job Objective:
Wash-over/ Mill an inflatable packer and push assembly down to bottom of the well. Tools used; 2-7/8" Motor, Bi-Di Accelerator and Jar with 3-3/4" Wash-over pipe and burning shoe.
Job Outcome:
The wash-over / milling BHA including accelerator and jar were RIH to tag top of packer. @ 8890ft. The wash-over and milling operation was completed and the packer was pushed down to 10868ft and left on bottom as per Client requirements.

Date: June 2002
Job Objective:
To recover/ cleanout gun debris and PDM motor using a 2.125" motor and 3.125 VJJB c/w a 3.5" toothed shoe.
Job Outcome:
This operation was achieved by using 3 different BHA's;

- 2.125" motor, 3.125" VJJB c/w 5ft extension and 3.5"toothed shoe
- 2.125" motorand a 3.5" taper mill
- 3.125" VJJB, 5ft extension and shoe

A total of 8 runs were made into the well to retrieve the debris, which was cleaned out successfully as per the customer's requirements. The debris recovered included: gun charges, motor stator, stator rubber and other metal debris.

Date: April 2002
Job Objective:
Clean out cement from tubing walls to allow access for perforating guns and to eliminate the possibility of cement falling onto and sticking the guns in the hole after firing.
Job Outcome:
The under-reaming BHA was run in the well on 1.25" and 1.5" tubing. The BHA consisted of a 2.125" motor, 2.125" under-reamer set to clean out to 2.990" and a 2.625" pilot mill. The tubing was successfully cleaned out from 7,080ft down to 10,400ft; this was confirmed by a caliper log survey done before and after the job. This job was carried out and completed as per the customer's requirements.

Date: March 2002
Job Objective:
Mill-out wiper plug and cement plug to cleanout well for future operations, BHA used included a 2.125" motor with a 2.625" cement/ junk mill.
Job Outcome:
The milling assembly was run into the well to a depth of 12,000ft, the motor was function tested at surface and again before the milling operation. After the initial slow progress the penetration rate increased down to a depth of 12,092ft the penetration rate dropped off slightly but the job continued until the target depth of 12,184ft was reached. At surface the mill was checked over and found to be pitted and badly scored on the OD and worn on the face. The well was cleaned out to the target depth as per the customer's requirements.

Date: May 2001
Job Objective:
Perform a scale cleanout in the tubing and through a DHSV to enable a clear passage to set a straddle across the DHSV giving safe access to cleanout the tubing below the Straddle and allow a cement plug to be set.
Job Outcome:
The first run was with a 2-7/8" Motor, 2 x Sleeve Stabilizer's and a Taper mill to open out a restriction at approx 60ft. The BHA was changed slightly and the well was cleaned out down to the DHSV. A 4.7" wash over shoe was used to clean the tubing walls down to the DHSV. Next a BHA was run to clean through the DHSV. After this was achieved wireline set the Straddle across the DHSV. Coil was rigged up again and a Jetting/ Cementing BHA was run to complete the remainder of the job. This job was completed to the customer's requirements.

Date: December 2001
Job Objective:
Clean out scale build up of scale inside 2-7/8" tubing using a 1-11/16" Motor with a 2.290" OD 3 Bladed Mill.
Job Outcome:
The Milling assembly was run in the well, milling operations started at a depth of 435ft and continued down to 3,200ft with minor resistance, steady progress was made throughout the whole job. Total in-hole time was 12hrs. The motor was function tested at surface before and after the job and the results showed that the motor was still in good operational condition. Slight wear on the mill was observed at surface. This job was completed successfully as per the customer's requirements.