ATP 685P

QUEENSLAND

TARDRUM 1

<u>WORKOVER AND TEST REPORT</u>

18 March 2004

Revision 2

SAMSON-INTERNATIONAL (AUSTRALIA) PTY LTD

Prepared by Upstream Petroleum Pty Ltd, 2004

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1 INTRODUCTION

1.1 Background

Tardrum -1 is situated in ATP 685P adjacent to and north of the established coal bed methane (CBM) fields Scotia (Santos) and Peat (OCA). This region is a proven hydrocarbon/coal province. Tardrum-1 was drilled as a coal seam exploration well at a crestal location on the Cockatoo Creek anticline. The well was designed to determine the volume of produceable gas and the productivity of the Upper Baralaba coal measures namely the C3, C4, C5 and C6 coal measures. The major uncertainty associated with the Tardrum resource prior to drilling the well was permeability of the cleat and microfracture system within the coal measures.

1.2 History

Tardrum-1 was drilled by Santos QNT Pty Ltd in July 2001. The well encountered four potentially productive coal seams (Lower C2B, C3, C4, and C6) within the Upper Baralaba Coal Measures and two interseam sand units (1A and 1B). The two sand units were tested by open hole DST with the upper 1B sand producing gas to surface. Both intervals were interpreted as being tight gas sands. The well was then cased with 5 ½" casing set at 1330.2 mRT and suspended.

During subsequent operations in August 2001 the production casing was found to be leaking at the port collar when pressure tested and a nominal 4" ID casing patch had to be run and set at 924.7 to 928.2 mRT. Each Coal Seam (C2B, C3/C4 and C6) was perforated and stimulated via foamed nitrogen fracturing with mostly 16/30 sand proppant, and flowed briefly back to surface. Each coal seam produced some gas during the flowback. The two interseam sand units were also perforated and stimulated using foamed nitrogen fracturing then flowed back to surface. The well was again suspended with a drillable bridge plug set at 648mRT.

A snubbing unit was mobilized in December 2001, drilled out the bridge plugs and frac baffles and installed a 2-3/8" packerless completion with the end of the tubing above the coal seams at 1080.3mRT. Originally the completion design included a packer but the 4.675" gauge ring would not pass a casing restriction at 777.5m. A 3.9" LIB was run on slickline and hung up briefly at the restriction, then went through. The configuration of the restriction is not known, except that it was identified subsequent to fracturing.

A Xmas tree was installed. The well was flowed back by Santos in January 2002 and produced gas and water continuously and did not clean up. Upstream Petroleum repeated the flowback testing for Sunshine Gas in March/April 2003 that confirmed the Santos results that gas and water was being produced continuously from the well. Upstream concluded from water level measurements in the well that the gas was most likely to have been produced from the 1A and 1B sandstone units. The presence of a small amount of condensate produced with the gas supported this conclusion. Upstream was unable to determine the source of the low rate water production. The stabilized gas production rate from the well was less than 0.1mmscfd.

1.3 Workover and Testing Objectives

The objective of the workover was to install a completion that would permit the complete dewatering of the coals and determine whether they were able to contribute to the total production from the well. In order to achieve this, the existing completion was retrieved and a Progressive Cavity Pump (PCP) installed to dewater the coals.

The well was to be tested sufficiently long to ensure that the water influx rate was known and the stable coal seam gas contribution measured by comparing the production rate determined during the previous test in April 2003, believed to be from the sands.

2 WELL DATA

Well Name	:	Tardrum-1
Well Classification	:	Gas Appraisal – Coal Seam Methane
Country/State	:	Australia, Qld
Permit	:	Cockatoo Creek Block, ATP 685P
Basin	:	Denison Trough
Operator	:	Samson-International (Australia) Pty Ltd
Permit Interests	:	Per Farm-in Agreement between: Santos QNT Pty Ltd and Sunshine 685 Pty Ltd, and between Samson-International (Australia) Pty Ltd and Sunshine Gas Limited
Location	:	Shot point 291 on line SG00-09 Lat 25^0 34’ 13.21” South Long 150^0 06’ 18.10” East Datum WGS 84/GDA 94 approx.
Drilling Rig K.B Elevation. Workover Rig Floor Elevation	: :	4.65 m above ground level 2m above ground level
Ground Level	:	194.4 m above sea level
Spud Date Workover Date	: :	July 2001 August/September 2003
Drilling Contractor/Rig Workover Contractor/Rig	: :	Oil Drilling and Exploration Pty Ltd Rig 4 Eastern Well Services Rig 2
Completion	:	Packerless 2 3/8” tubing completion with end at 1085.7m, and Progressive Cavity Pump (after Recompletion #2)
PBTD	:	1313.4 mRT

3 WORKOVER ACTIVITIES

3.1 Recompletion # 1

Eastern Well Services Rig 2 was mobilsed to location on 21st August 2003 and was rigged up on 22nd August. The mud pits were cleaned with pressure cleaning equipment to remove any solids, scale or rust. The mud pits were filled with fresh clean water and the pipe work and pumping equipment circulated clean. Solids contaminated water was dumped via the flare line to the flare pit. 150bbls of 9.0 ppg KCl brine was mixed and 200ppm biocide (gluaraldehyde) and 200ppm oxygen scavenger (Ammonium Bisulphite) added.

The flare line was made up with 2 7/8" tubing to the flare pit and star pickets installed to hold down every joint.

Temporary chicksan piping was hooked up to the well annulus and well pressure bled off to the flare pit via the choke manifold. The gas rate was measured via the choke nipple and two gas samples were taken in the 20 litre evacuated sample bombs per ASTM procedures (sample bottles ACS 1018 and 1002) and sent to ACS Laboratory for chromatographic analysis. ACSL provided evacuated gas sample bottles, not intended to be purged with wellhead gas.

KCl Brine was circulated down the tubing and gas returns from the annulus flowed via the choke manifold to the flarepit. Completion fluid was lost to the formation and additional brine had to be mixed 8.6 ppg brine was mixed due to lack of KCl. The well was circulated with brine but could not be killed with this brine weight. A pressure at surface of around 340psi resulted. A Back Pressure Valve (BPV) was installed in the tubing hanger and the Xmas Tree and 7-1/16" adaptor flange removed. The workover BOP was installed. The 2-3/8" landing joint was run and screwed into the tubing hanger, the BOP was tested to 2000psi and the annular preventer to 1200psi.

The brine weight was increased to 8.8ppg on arrival of additional KCl and this was circulated around but the well was still observed to be flowing slowly. The brine weight was increased in stages up to 9.6ppg while continuing to circulate the well. Minor losses were experienced while circulating. After circulating the well was observed for a short period and was seen to flow slowly. The annulus was left open to the flare overnight and it was found to be flowing gas at a rate of 34mscf/d by the morning. It was concluded that the KCl losses were probably to the coals, and the gas flow was probably from the sandstone perforations.

It was decided that as the well flowrate was very low and that the shut- in pressure was low and built up slowly that the removal of the completion would proceed by stripping the tubing out of the hole while flowing the annulus to the flare. A JSA was held to review this procedure.

Slickline was rigged up and attempts made to set a 1.875" PX plug in the Otis X nipple profile to prevent gas flow up the tubing during the completion retrieval process. As a consequence of scale build up in the nipple profiles attempts to set the PX plug were aborted. The scale was checked with Hydrochloric acid and found likely to be Calcium Carbonate.

The tubing hanger was unlocked, removed and laid down and the completion stripped out of the hole. The completion string as shown in Well Completion Schematic after Recompletion #1 in Appendix 7.2 was run including a PCP stator and torque stopper. The PCP was a

Corlac 24-1800 pump, which is rated to lift 1800m of water head at 24m3/day per 100 rpm. The pump was run with the suction of the pump at 1243.8m putting it at about 18 m below the lowermost perforation in the C6 coal measure. The completion was run with a 1.875" PX plug and prong preinstalled in the X nipple at 1065.9m and landed. The tubing hanger was locked down and the seals were tested to 2000psi. The BOP was removed and tubing head adapter flange and Xmas tree as shown in Appendix 7.3 installed. Slickline was used to retrieve the PX plug and prong.

Note: Due to the live well and unavailable large bore lubricator, a 4.25" casing drift could not be run to check passage of the torque stopper through the casing collapse point so the torque stopper was run in the completion string such that it was above the collapse point.

The 1500PSI WP Ratigan rod BOP was installed on the top of the Xmas tree and the PCP rotor RIH on 7/8" API Grade D rods as shown in Appendix 7.4. The rotor was spaced out in the stator by running to tag the tag bar and then adjusting the rod length to suit. With the PCP rotor picked up out of the stator the tubing was filled with drill water and the pump out plug at the end of the tubing pumped out of the end of the string. The 1.25" polished drive rod and polished rod stuffing box were installed on top of the polished rod BOP and the electric drive head and 2:1 drive ratio, 3V-belt pulley system rigged up and connected to the temporary generator.

The surface test equipment was hooked up to the well. The well annulus valve was piped to a test choke manifold and divertor system such that gas could be flared directly or could be routed to a fixed orifice type flow prover.

The fluid pumped from the well by the PCP pump via the wing valve was piped to a 30 bbl two-compartment test tank, which could be used to measure the produced water rate. The test tank water was discharged to the flare pit.

The PCP pump was started at 11.20 on 2nd September at 100 rpm. Water was produced to surface within a few minutes, which was initially clear. A sample of the water was taken and its fluid weight measured as 9.4ppg (completion brine). The water level in the annulus was monitored using an Echometer throughout the test. The PCP ran smoothly initially with minimal torque and operated at close to 100% efficiency when compared with the manufacturers pump curves. The pump speed was increased to 300rpm to test the performance of the pump and then reduced back to 150rpm. The pump performed at 100% efficiency when compared with the manufacturers pump curves. Some evidence of coal fines was observed and the produced water samples taken revealed that the density of the water had reduced to 8.55ppg (mainly formation water). The workover rig was released at 0630hrs on 3rd September.

On 3rd September the pump was running at 150rpm with minimal torque. The annulus gas rate reached a maximum measured rate through the choke nipple of 259mscf/d with the casing pressure reaching 29psi. The measured fluid level in the well annulus at this time was around 600m (180m above the top sand perforations). There was no evidence of gas being produced via the tubing, which was expected because the pump suction was below the lowermost perforations. At 11.16 on 3rd September the PCP drive belts were observed to be slipping and so the pump was shut down and the belts and sleeves replaced with a stronger, 4 belt system, still on 2:1 drive ratio. The pump was successfully restarted on 4th September and ran for at least a further 4.5 hours. Around 2400 hrs on 4th September the PCP motor shut down on overload protection. Attempts to restart the pump were unsuccessful and it was determined that the pump was jammed downhole, probably with coal fines which had been evident in pumped water during the latter stages of the test. Early morning on 6th September a crane was mobilized to recover the rod string as it was thought that the coal fines in the completion string would fall into the well sump once the PCP rotor was removed from the stator. On attempting to lift the rod string it was found that the rod string was stuck. The load applied to the rod string was increased to 35,000 lbs when the top 7/8" sucker rod parted under tension. This was dealt with as an incident report as the polished rod was released from the crane hook and dropped to the ground, bending it. No one was injured. Calculations have revealed that the rod parted under a load that was 25% less than its rated tensile strength, however the torque applied to the rods may have exceeded rod plastic torque limit when the rods jammed.

3.2 Recompletion #2

On 8th September Eastern Well Services Rig 2 was remobilized to workover the well. The Xmas tree and tubing spool adapter flange was removed and the BOP installed with the well still flowing gas from the annulus and a casing pressure of 1 psi. The tubing hanger was unlocked and the completion string and rod string retrieved together. Seventy seven 7/8" rods in the upper part of the string were found to be bent. The 2-7/8"x 2-3/8" crossover and a single joint of 2-3/8" tubing had unscrewed and fallen off the end of the completion string and fallen into the well sump. As the rotor was removed from the stator of the PCP prior to the pump arriving at surface, the material which was jamming the rotor or rods would have fallen into the well sump. Hence no hard evidence was found of what was jamming the PCP pump.

A 4.5" drift was run on the rig's sandline to the top of the casing patch at 924.5m, while leaving the annulus open at <1psi to the flarepit. A second drift run was run to tag the fill at 1289.3m which was some 24.1m higher than indicated in the Santos well completion schematic and 19.8m higher than measured during the Sunshine gas flowback test performed in March 2003. This indicated that there had been a substantial volume of solids, presumed to be frac sand and coal fines which had flowed into the well since the frac jobs were completed by Santos in 2002, and that probably most of this occurred during the PCP Pump test. The fill material was not sampled with slickline, which would have given an indication of the nature of the solids, which had flowed into the well and had caused the PCP pump system to become jammed.

On 11th September the completion string was rerun to position the pump suction above the top of the coal perforations as it was thought that this would prevent coal fines jamming the PCP rotor and rods. A hydrocyclone type gas separator was installed below the PCP pump to minimize the ingress of gas into the pump suction from the coals below. Problems were experienced in getting the 3.625"OD gas separator to pass the casing patch in the well. After performing a number of drift runs and grinding a 45-degree leading edge bevel onto the gas separator, the completion was able to be landed and the tubing hanger locked. The BOP was rigged down and the tubing spool adaptor flange and Xmas tree installed. The rod string was RIH but was found to be hanging up just prior to landing the rotor on the tag bar in the stator. KCl brine was reverse circulated to try to move whatever was causing the rods to hang up without success. The rods and PCP rotor were recovered and it was found that the rotor had a sharp lip on the end indicating it may have been hanging up on something hard. The well was again reverse circulated without the rods in the hole. Some coal fines, condensate, small pieces of rubber and a piece of Teflon (possibly part of a seal of a ball valve- not part of a rod guide as all guides were accounted for and undamaged) were circulated out. None of these items were attributed to the PCP jamming.

On 16th September the rotor and rod string were successfully run and the stuffing box and surface drive reinstalled now with a 2.5:1 drive ratio, to allow slower pump speed. At 11.30 the pump was restarted but tripped on overtorque detection. This was found to be caused by incorrect settings in the motor controller and after further checking of the motor electrical connections the pump was successfully started at 17.50 on 16th September. The pump was run at a constant minimum speed of 57 rpm and care taken to reduce the fluid level in the well slowly. The workover rig was demobilized on 17th September once it was thought that the pump was operating reliably.

At 13.00 on 20th September an annulus gas sample for analysis at ACS Laboratory was taken which would be representative of the gas produced from both the coals and the sands. A sample of formation water was taken from the tubing for analysis at ACS laboratory at 14.00 hrs on 20th September. The water being produced at this time had some minor coal fines but was largely clear.

Throughout the test water production was surging from the well due to gas production from the coals being entrained into the pump suction, increasing as the annulus fluid level lowered. The gas production rate from the tubing string also increased throughout the test. Back pressure was applied to the tubing to reduce the surging by throttling on a downstream valve. At 10.50 on 21st September the test was briefly halted to install a variable choke downstream of the production wing valve to allow better control over the surging liquid flow from the tubing. The pump efficiency gradually reduced through the test to around 42% indicating a gradually increasing gas production rate from the coals as the fluid level in the well was reduced.

The water density produced from the well stabilized at 8.3ppg indicating that the formation water was extremely fresh. This confirmed the 7000ppm Chlorides measured by refractometer during the flowback performed in March - April 2003.

The maximum annulus gas flow measured via choke nipple on the test was 39.2mscf/d with a further estimated 5-10 mscf/d pumped with the water out of the tubing. The much lower total gas rate in the second test when compared with the first test is attributed to the fluid level in the well being only 488m in the second test whereas the fluid level was drawn down to 716m in the first test.

At 03.00 on 22nd September a rapid rise in motor torque to 18% (as indicated on the variable speed drive LED panel) was observed. At 03.20 the torque fell to zero suddenly. The motor continued at 57rpm until it was shut down at 03.25. The variable speed drive indicated the failure mode of OL3 - torque overload. It was determined that the rods had sheared due to over torque an unknown distance down the well. To the time where the rods failed the fluid level in the well had been drawn down to 488m. Analysis of the failure of the rod string indicated that the string had probably been over torqued.

Failure of the pump was thought to be caused by coal fines and/or frac sand becoming trapped between the 1.83” outside diameter rod guides, 1.81” outside diameter rod collars and the 1.995” inside diameter of the 2-3/8 tubing.

On 26th September it was decided to discontinue further testing on Tardrum-1. On 27th September a smaller crane was mobilized to demobilize the test equipment and recover the rods above the parted rod and secure the well. The crane was unable to pull the rods out of the well at maximum pull of 17000Ib, and the rods could no longer be rotated by hand, indicating solids had settled around the rod string above the point of failure. The rod string was landed on the Ratigan rod BOP and the well secured by screwing a 2-7/8” tubing pup joint and bullplug into the top of the Ratigan BOP to cover the rod stick up. Tubing gas samples were taken for analysis by ACS Laboratory on 26th, 27th and 29th September following which the Ratigan rod BOP was closed to act as a second barrier. All equipment including the drivehead and motor were demobilized and the site cleared of any rubbish as of 29th September.

4 DATA ANALYSIS

4.1 Water Inflow Rate

As the pump failed on both tests prior to the liquid level in the well being drawn down to close to the pump suction, the well flow had not stabilised. The objective was to lower the liquid level to below the level of the perforations being tested which was not achieved.

However, on the first test we can estimate the rate of inflow of water into the well towards the end of the test. If we look at the period between 7.00hrs and 10.00 hrs on 3rd September, the annulus fluid level was lowered from 395 to 595 m. At all times the tubing was full of water as the pump suction was below all gas producing intervals. During this period the pump was pumping at a constant 150rpm or 216 bpd.

The volume of liquid in the annulus between 2-3/8" tubing and 5-1/2" 17ppf casing from 395m to 595m is:

Annular volume = (595-395)*0.01776/0.3048
= 11.65 bbls

Volume of water pumped from the well = 216*3/24
=27 bbls

Therefore with the water level at 495m and 1 psi annulus pressure

Water inflow rate = (27 – 11.65)*24/3
= 122bpd

This compares with field estimates of water inflow rates made on the morning of 3rd September, being 158 BWPD/fluid level 395m, and 126 BWPD/fluid level 594m. While fluid level data is affected by rising annulus gas bubbles, it is evident that water rate decreased and annulus gas rate increased as the annulus fluid level was drawn down.

On the second test the well was pumped for several days with the fluid level falling to around 488m with a casing pressure of around 32 psi. Within the accuracy of the measurements the backpressures on the producing formations had fallen to approximately the same level as the case above during the first test. Over the last 12 hours before the pump failure the fluid level in the well was static at around the 490m level. The pump rate was therefore equal to the inflow rate at that time. Hence the water inflow rate at the end of the second test was around 36 bpd, with the pump operating at 57RPM throughout the second test.

From the above it can be deduced that the water inflow rate was not stabilised on the first test and that a fairly stable rate of 36 bpd had been established with the fluid level at around 490m below surface. Clearly, further drawdown of the liquid level and dewatering of the coals would have required a higher pump speed should the liquid level in the well have stabilised at the 490m level. Increasing pump RPM was intended on the morning the rods failed during the second test.

If we assume that the stabilised water inflow rate with the liquid level at 490 m is 36 bpd and that the water inflow rate with a full liquid column to surface is zero and assuming radial flow, then to dewater the coals to the base of the C6 perforations at 1225mKB will require a pump rate of approximately:

Pump rate to dewater coals to base of C6 perforations = 36* (1225/490)
= 90 bpd

As the water production rate had probably not fully stabilised it is likely that a rate of less (and perhaps significantly less) than 90bpd will be required to maintain the liquid level in the well at the level of the lowermost C6 perforations.

4.2 Gas Inflow Rate

As the water level in the well is drawn down the back pressure on the producing formations is reduced and the flowrate of gas increases. For tight sand reservoirs the inflow performance is defined by the backpressure equation.

$Q = C(Pr^2 - Pwf^2)^n$

In order to resolve this equation at least three flow rates and stable fluid levels would be required to determine the absolute open hole flow potential of the gas reservoir.

Given the limited amount of data available and taking into consideration that the well flow was not stabilised only a qualitative analysis of the gas flow data has been possible.
It was concluded in March 2003 that the majority of the gas flow was being produced from the sandstone interval as the liquid level was at 968 m which was above the top of the uppermost coal perforation at 1108 m, and condensate was observed. With the liquid level at 968m a fairly stable gas flowrate of 64mscf/d was achieved with a surface casing pressure of 51psi.

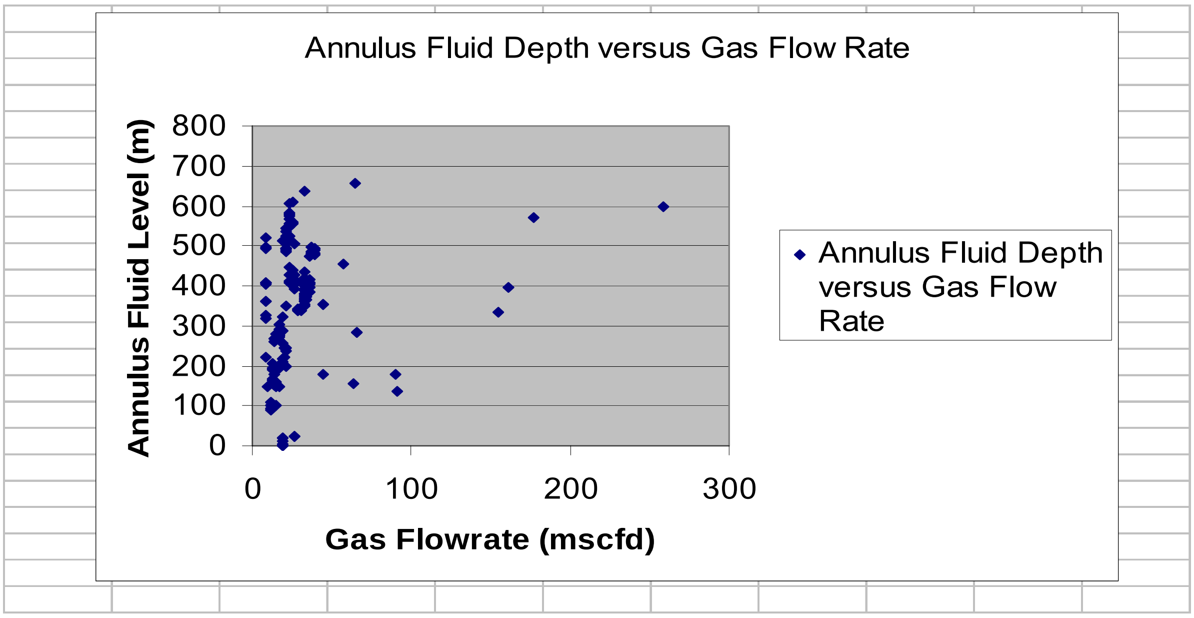
Data from test # 2 however does not fully support this conclusion as gas was observed in the produced fluid from the tubing when the liquid level was drawn down only 150m from surface. The suction of the pump was below the gas producing perforations and hence the tubing gas must have been produced from the coals. However it is correct to say that typical rates of gas production from coalbed methane wells is low until the cleats are almost fully dewatered. It is also possible that the coal horizons were reacting to water being drawn from them rather than from the open sand horizons (no measure of differential water production from the sands and coals is available).

In test # 1 the fluid level was drawn down much deeper than test #2. Although the duration of this test was short, casing gas production rates of up to 259mscf/d (briefly –possibly a gas bubble) were recorded with a casing pressure of 22 psi. The water pumping rate at this time was around 220bpd which is double the estimated rate required to dewater the coals and the fluid depth measured by Echometer was stable at around 600m. Given that a substantial influx of gas was indicated the measured liquid level would likely be much higher than the effective fluid level due to bubbles of gas rising through the liquid column. It is possible that the rapid increase in gas production indicated that the coals had in fact started to be dewatered. It is not possible to estimate the maximum gas production rate from the well once the coal cleats are completely dewatered as there was insufficient data collected prior to pump failure, however a stabilised gas rate in excess of 259mscf/d would seem likely.

It should also be noted that coal fines in produced water, and increased torque related to solids movement (resulting in pump/rod string lockup on 3 occasions) occurred as the annulus fluid level was drawn deeper. This is indicative of a volatile coal reaction to changes in hydrostatic pressure and water production from the coals.

Low gas rates are typically produced from coal seams until the cleat is substantially dewatered, hence it can be concluded that the majority of the gas during test # 2 was produced from the sands. With the fluid level in the well at 495m the produced gas rate from the casing was around 38mscf/d and from the test performed in March 2003 where the water level was below the sands the gas production rate was 64mscf/d. It can be concluded that the absolute open hole flow potential of the gas sands as currently completed is in the range 60-70mscf/d.

The chart below is a crossplot of gas flowrate from the annulus versus the annulus fluid level.



The volume of gas produced from the tubing at the end of test #2 may be estimated as follows:

Volume of liquid pumped at the end of test #2 = 36bpd = 5.723 m3/day

Pump efficiency = 41.81%

Therefore volume of gas pumped at bottom hole conditions = 7.965 m3/day

Assuming that the gas is methane and the following equation applies

PV= znRT, where z is the compressibility of methane.

The pressure at the pump discharge at the end of test #2 = ((1066-490)x1.42) +32
= 850psi

The bottom hole temperature is 50 degC or 323K

The compressibility of Methane at bottom hole conditions is approximately 0.97

Hence,

The volume of tubing gas (all from the coals) produced at the end of test #2

$$= \frac{850 \times 7.965 \times 288 \times 0.97}{14.7 \times 323}$$

$$= \underline{398 \text{ sm3/day} = 14.1\text{mscf/d}}$$

If we add this to the casing gas (co-mingled coal and sand flow) production rate at the end of test #2.

Total gas production rate with the fluid level at 490m from surface = 38+ 14.1= 52.1 mscf/d

4.3 Gas Composition

The samples denoted flare line gas in bottles ACS 1018 and 1002 were representative of the gas sitting in the well prior to the workover activities and would have been largely gas produced from the sands during and after the flowback performed in March – April 2003.

The sample denoted wellhead gas in bottles ACS 1019 taken at 1300 on 20th September was taken from the annulus and will be a mixture of coal seam gas and gas from the sands with most of the gas likely to be from the sand.

The gas samples denoted ACS 1026, 1015 and 1033 were taken from the tubing after the failure of the pump on the second test and hence should be representative of gas produced from the coals only.

What is striking from the results is that the apparent composition from the sands and the coals is very similar and the Nitrogen content of all samples is high with the highest reading being over 14%. The high Nitrogen content is consistent with the Nitrogen levels ACSL recorded in the gas evolved from the Tardrum 2 bottoms up samples (13.5% Nitrogen) and the C3 coal seam side wall cores (14.78% Nitrogen) during gas desorption testing.

4.4 Produced Water Composition

The produced water sample had a chlorides content of only 6240mg/litre. This compared well with the 7000ppm measured via refractometer in the field in March – April 2003. The produced water is hence almost fresh water. The Calcium content of the water is not particularly high, so the Calcium Carbonate found in the nipple profiles upon recovering the original completion is of concern. All the completion equipment and tubing run downhole by Santos was new. The nipples were all pressure tested with plugs before running, and ran with 2 tailpipe plugs, pulled before suspending the completion. No air was pumped into the well after running the completion (which can lead to scale precipitation). Hence the scaling had to result from standing well fluids and from the flowback attempts by Santos in January 2002 and Sunshine Gas in April 2003. More work is required to identify the source of the scaling, which has the potential to become an expensive production problem.

5 CONCLUSIONS AND RECOMMENDATIONS

The Tardrum #1 well test did not achieve all its objectives, however the following conclusions can be drawn:

- The pumping rate required to maintain the coals in a dewatered state has been calculated and can be used for future pump sizing. The estimated pumping rate required is around 90 bpd or less.

- The absolute open hole flow potential of the sand reservoir as presently completed is of the order of 60-70 mscf/d which on its own is unlikely to be commercial.

- Once the coal cleats are substantially dewatered the rate of gas production increases rapidly and the stable rate of gas production is likely to exceed the maximum recorded rate of 259 mscf/d.

- The Nitrogen content of the gas in the coals is high and has been measured at over 14% in some samples. The high Nitrogen content was could have been a consequence from the nitrified fracture treatment however, Tardrum-2 sidewall core and bottoms up samples also give high Nitrogen contents during desorption tests indicating the actual produced gas Nitrogen content is likely to be high throughout the field production life. The impact of this high inerts content, which is double the likely pipeline specification, on the commerciality of the Tardrum Field development will have to be assessed.

  It is recommended that further production testing of the Upper Baralaba coal measures be carried out to determine the full extent of their productivity. The objective could be achieved through further testing of Tardrum 1, however this would not be ideal as it will not be possible to accurately differentiate the production from the sands and the coal. A better test would be to perforate and hydraulically fracture the coals only in Tardrum 2 and perform a test on that well, as intended. In either case changes will need to be made to the completion design to prevent the catastrophic failures of the rod string encountered during the Tardrum 1 test. It would be beneficial to obtain a sample of the fill in Tardrum 1 when recovering the present PCP completion, to determine the nature and sizes of particles which contributed to the pump jamming.

  The completion to be run for further testing will require a larger clearance between the inside diameter of the tubing and the outside diameter of the rod couplings and rod guides. 2-7/8" or 3-1/2 " tubing will be required and a thorough review of rod size and rod guide combinations made.

  The existing Corlac progressive cavity pump and surface pumping arrangement although on the large side can be made to have sufficient turndown to pump at the estimated dewatering rate of 90 bpd. The pump rate can be lowered to 86 bpd (assuming 100% efficiency because the pump suction is placed below the bottom perforation) without any changes to the belt and pulley arrangement used, however this is sub-optional for pump motor cooling, and at minimum RPM the variable speed drive system is largely ineffective in it's ability to prevent over torquing. Hence the mechanical drive system requires review to address these issues.

The most meaningful test and the highest possible gas rates will only be achieved if the coal cleats can be completely dewatered and it is therefore recommended that for production the pump be situated below the lowermost coal perforation. In this position the pump will be susceptible to ingress of coal particles and potential for jamming the pump and rod string. To minimise this possibility it is recommended that the test well be initially air lifted using a rented spaghetti string, progressively lowered into the well inside the production tubing, until the coals are completely dewatered. Alternatively a high pressure airpack could be used without the spaghetti string. During the dewatering process with air any coal particles which are not adhered to the cleat will be moved into the well bore. Solids production with the PCP pump installed should therefore be minimised.

Once the PCP pump is installed, the completion should be designed such that particles of coal which fall into the wellbore either settle into the well sump or if they are drawn into the pump suction the fluid velocity in the tubing is sufficient to lift any particle out of the well which may cause the pump to become jammed.

Further water and gas samples need to be recovered with care, and analysis performed to determine the scope of Nitrogen inert contaminants in gas and scaling tendency in water.

6 APPENDICES

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