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COALBED METHANE

Final Report
Roc Oil/RMOTC Hydraulic Pump Test

For

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Executive Summary

Roc Oil (ROC) has a majority interest and acts as Operator in a JV project (Cliff Head) in the Offshore Perth Basin. The wells in the field do not have sufficient reservoir energy to produce at the desired rates without some form of artificial lift. One of the artificial lift methods under consideration, a hydraulic positive displacement pump (PDP), is the subject of this test and evaluation. The pump equipment design was developed by Oilwell Hydraulics, Inc. (OHI).

For the subject test OHI took their Type EM Bottom Hole Pump and upscaled it to run in 5-1/2" tubing and produce at a maximum designed rate of 13,440 BPD. For the test, the pump was to be operated at a production rate of 4,000 BPD and then 8,000 BPD. OHI made the decision to test the upscaled pump at the Rocky Mountain Oilfield Testing Center near Casper, Wyoming. The site is owned by the U. S. Department of Energy.

Extreme Petroleum Technology, Inc. (EPT) was contracted by Roc Oil to participate in the testing of the hydraulic pump at RMOTC. EPT was to act as a third party witness in the test design, test site selection, test monitoring and reporting, test documentation and preparation of a final report.

Primary objectives established for the test were to quantify the downhole pump efficiency, confirm that the pump can be deployed and retrieved hydraulically and determine the extent of wear and/or damage sustained by the pump, BHA and standing valve assembly throughout the course of the test.

The test was conducted in two stages. The first stage ran from July 23, 2004, to August 4, 2004. The pump was then retrieved and shipped to Odessa, TX for tear down and evaluation. There were no EPT personnel on site for the second test stage or either of the PDP tear downs and evaluations. It is understood the second test stage was started on August 24, 2004, and terminated on September 11, 2004. Though no formal information was received it is also understood that the PDP, BHA and standing valve were in good condition and showed little sign of wear following the second test stage.

Conclusions

1. The PDP operated as specified during the first test period.
2. The lubricator worked successfully.
3. Vibration, pressure surges and suspended solids caused problems affecting all parts of the system resulting in numerous line leaks and equipment failures.
4. There was an appearance of confusion over who was ultimately directing execution of the test.
5. The specifications to obtain a test fluid similar to the Cliff Head water were never attained.
6. The pump was hydraulically deployed and retrieved successfully.
7. Corrosion and/or erosion of the pump rod were found when the pump was inspected following first test stage.

Recommendations

1. There needs to be improvements in both pressure monitoring and flow measurement. This should be possible with better pressure gauges, placement of the gauges and dampening of the pressure surges along with better stabilization of the piping. A meter that functions on the Coriolis Technology principle (i.e. Micro Motion Model D150 or D300) should operate under the test conditions and is recommended.
2. Develop a process spreadsheet for monitoring the test in an effective manner.
3. Designate one person onsite who is in charge of the test.
4. Assure the water storage facilities are clean before starting the test.
5. Better equipment (blender or hopper) to assure the correct mix of the dry chemicals.

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Introduction

Background

Roc Oil (ROC) has a majority interest and acts as Operator in a JV in the Offshore Perth Basin. It has a small oil discovery at Cliff Head, approximately 10 km offshore near Geraldton, WA, approx 200 km north of Perth. Cliff Head is 14 km from a proposed plant.

The field development envisioned at the time of this test is to be produced from 6 wells on a wellhead platform. The wells do not have sufficient reservoir energy to produce at the desired rates without some form of artificial lift. One of the artificial lift methods under consideration, a hydraulic positive displacement pump (PDP) artificial lift system, is the subject of this test and evaluation. These pumps are expected to provide the pressure to pump the fluids onshore. Design production rate is 20,000 BOPD and 20,000 BWPD per platform. Oil production is expected to fall off rather quickly and produce at high water cuts. Crude is 33° API with a very high pour point of 35°C, a GOR of only 38 SCF/bbl, and a bubble point of 375 psia at the reservoir temperature of 70°C.

The crude oil will be pumped to shore in an insulated 10" or 12" pipeline to arrive at the plant at 55°C minimum. Warm power fluid at 60°C for the PDP's will come from onshore pumps and be transported to the wellhead platform via a second insulated 10" or 12" pipeline.

The PDP's will be of a new design provided by Oilwell Hydraulics, Inc. (OHI). They will have a 5" EM type design. The largest pump of this type currently produced by OHI is a 3" and it will need to be scaled up for the modeled flow rates. The design is complete, and two prototypes have been built.

One of the pumps was tested at the U. S. Department of Energy's Rocky Mountain Oilfield Testing Center (RMOTC) near Casper, WY. The tests were originally scheduled to take place in late March, but did not actually start until July 2004.

Extreme Petroleum Technology, Inc. (EPT) was contracted by Roc Oil to participate in the testing of the hydraulic pump at RMOTC. EPT was to act as a third party witness in the test design, test site selection, test monitoring and reporting, test documentation and preparation of a final report.

The scope of this report is limited to the testing at RMOTC.

Test Objectives

Experience with RMOTC testing projects has taught us that thorough definition of specific test objectives is critical to obtaining acceptable testing results. The following test objectives were established by Roc Oil prior to the test:

1. Confirm and quantify pump deliverability
2. Verify criteria for OHI's pump performance model
3. Quantify the efficiency (both volumetric and energy) with respect to time (pump wear), when tested with fluids similar to those expected at Cliff Head, and at pressure conditions similar to those anticipated for the high rate Cliff Head wells.
4. Quantify the rate of power fluid leakage into the produced fluid, with respect to time (pump wear)
5. Confirm that the pump can be deployed and retrieved hydraulically.
6. Determine the extent of wear (and/or damage) sustained by the pump, BHA and standing valve assembly throughout the course of the test.
7. To measure the force required to pull a pump through a section of curved tubing at various doglegs, and quantify the maximum dogleg that the pump is able to pass through.
8. Conduct a fit test (trial completion) of the BHA in the appropriate casing size with control lines strapped to the BHA. (Discussions with OHI should lead to 4 control/chemical injection lines being accommodated within the current profile of the BHA collars).

9. Establish procedures and time estimates for:
   a. BHA handling and running during completion installation
   b. Stab-in, space-out and landing of central (5 ½" or 6") completion in stab-in receptacle
   c. Pump deployment during completion as well as the jet pump for the clean-up period.
   d. Pump workovers, for both hydraulic and wire line based workovers.
   e. Standing valve assembly (body) retrieval, redress and running.
10. Conclude various design issues such as:
   a. Metallurgy of downhole components
   b. Seal design and material specification (Elastomer type not yet specified)
   c. Stab-in receptacle design and anchoring of the central tubing
   d. BHA seal-bore wear and remediation.
   e. BHA design, with respect to control line clamps and placement
   f. BHA component connection designs (thread forms and seal requirements)
   g. Dummy pump design, handling, running and redress
   h. BHA seal-bore protector and port isolation device design, specifications, handling, running and redress
   i. Additional tooling requirements
   j. Support for training Cliff Head personnel in the operation and maintenance of the PDP's, including their installation and retrieval
   k. Establish ongoing support for the Cliff Head PDP's

Hydraulic Pump Design

The pump equipment design was developed by Oilwell Hydraulics, Inc. Specifications for the pump are shown in Figure 1.

A well will flow if it has sufficient reservoir energy (pressure) to push fluid to the surface. Artificial lift is applied to a well if the reservoir pressure is not sufficient to cause the well to flow, or when more production is desired in a flowing well. In either case, energy must be transmitted downhole and added to the produced fluid. Hydraulic pumping systems transmit power downhole by means of pressurized power fluid that flows in wellbore tubulars. The downhole pump acts as a transformer to convert the energy of the power fluid to potential energy or pressure in the produced fluids.

An information sheet about the hydraulic pump is shown in Figure 1. Also there are detailed pump drawings prepared by OHI in the Appendix for reference.

For the subject test OHI took their Type EM Bottom Hole Pump and upscaled it to run in 5-1/2" tubing and produce at a maximum designed rate of 13,440 BPD. For the test, the pump was to be operated at a production rate of 4,000 BPD and then 8,000 BPD.

A hydraulic Positive Displacement Pump (PDP) transfers the power fluid energy to lift the produced fluid to the surface by means of a double acting piston arrangement. This consists of having an upper and a lower cylinder and an upper and a lower piston system with the pistons connected by the pump rod. The pump is designed with a seal and valve system so that as the pressure of the power fluid is applied to the rod end of the piston it forces the produced fluid out of the well. As this occurs the other cylinder is being filled with new produced fluid and the cycle is repeated again.

There are two types of operating fluid systems, either a closed power fluid (CPF) or open power fluid (OPF) system. In a CPF the power fluid is not commingled with the produced fluid for return to the surface while in an OPF system the power fluid is commingled with the production for return to the surface. In most field applications the power fluid is pumped down the tubing to operate the pump and the return fluid and production fluid may come to the surface through the annuls or another string of tubing.

To facilitate the evaluation of the pump performance during the OHI test each fluid stream, power fluid in and out and production in and out, had individual flow strings.

Hydraulic Pump Characteristics:

PUMP SIZE	DISPLACEMENT			AREA RATIO	
	Pump End at Rate Speed (BPD)	(BPD per SPM)			
		Engine	Pump	P/E	E/P
5 x 4	13440	391	444	1.134	0.880

PUMP SIZE	Max. Fluid Lift (ft)	Approx. Pump Length (in)	Approx. Pump Weight (lb)
5 x 4	8,800	448	590

OILWELL HYDRAULICS, INC.
SINCE 1991

Type EM Bottom Hole Pump
Standard Circulation

Optimum high volume pumping capacity is provided by a long slow stroke pump design that minimizes wear, and operating cost. The double acting high compression ratio, multiple seal, free pump design also reduces chances of gas locking. The special design uses only two pistons that exchange roles from pump plunger to engine piston in the up stroke and down stroke.

PUMP SIZE Nominal x Pump (Inches)	Part Number	DISPLACEMENT Bump End At Rated Speed (BPD)	(BPD per SPM) Engine	(BPD per SPM) Pump	Area Ratio P/E	Area Ratio E/P	Max. Fluid Lift (ft)	Approx. Pump Length (In)	Approx. Pump Weight (lb)
Fits in 2 3/8" OD Tubing or larger									
2 x 1 3/8	4E-00-22-0	1317	17.59	20.27	1.152	.868	8,700	156	75
Fits in 2 7/8" OD Tubing or larger									
2 1/2 x 1 3/4	5E-00-22-0	2400	34.45	40.63	1.149	.873	8,700	185	110
Fits in 3 1/2" OD Tubing or larger									
3 x 2 1/8	6E-00-22-0	4007	62.77	71.70	1.142	.876	8,700	220	165
Fits in 4 1/2" OD Tubing or larger									
4 x 2 7/8	8E-00-22-0	8135	162.53	184.90	1.137	.880	8,800	285	245
Fits in 5 1/2" OD Tubing or larger									
5 x 4	10E-00-22-0	13440	391	444	1.134	.880	8,800	448	590
Fits in 6 5/8" OD Casing or larger									
6 x 5	12E-00-22-0	20970	614	699	1.138	.878	8,700	540	650

NOTE:
Last 3 digits of part number are: 21-0 OPF (Open Power Fluid); 22-0 for CPF (Closed Power Fluid) Production Unseat; and 23-0 for Closed Power Fluid PRU (Power Return Unseat).

PUMP STROKE LENGTH: For 2" pump. 48"; for 2 ½" pump, 57"; for 3" pump, 68"; for 4" pump, 96"; for 5" pump 120"; for 6" pump 142".

MAXIMUM PUMP OD: For 2" pump. 1.889"; for 2 ½" pump, 2.326"; for 3" pump, 2.826"; for 4" pump 3.826"; for 5" pump 4.826"; for 6" pump 5.815".

MAXIMUM RATED SPEED: For 2" pump, 65 SPM; for 2 ½" pump, 59 SPM; for 3" pump, 56 SPM; for 4" pump, 44 SPM; for 5" pump, 30 SPM; for 6" pump, 30 SPM.

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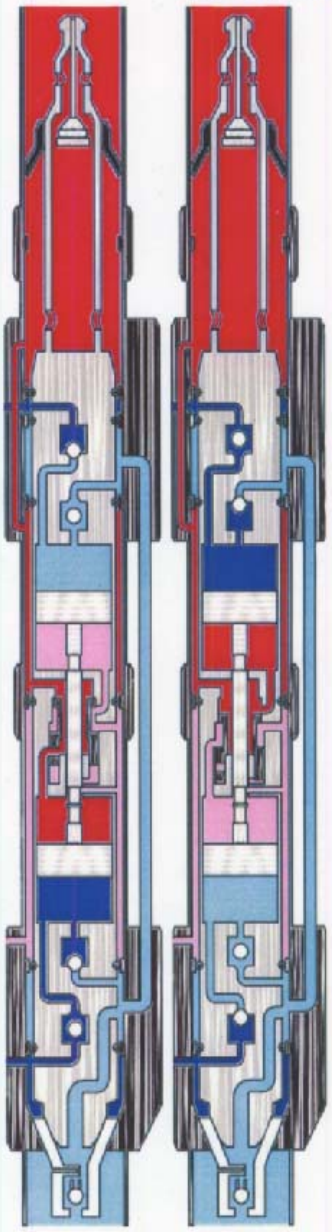


Figure 1 Hydraulic Pump Design from OHI

Figure 2. RMOTC Test Site

Test Site Selection

OHI made the decision to test the upscaled pump at the Rocky Mountain Oilfield Testing Center near Casper, Wyoming. The site is owned by the U. S. Department of Energy. It is an old oil field that has largely been depleted and converted to use as a test site for oil and gas technologies.

The site for testing the pump needed to have control of both the power fluids and the produced fluids downhole. For this reason, a standard well bore would not suffice. The well bore diameter was required to be large to accommodate the pump and the fluid tubulars. For this reason, no existing well would fill the requirements. A new well had to be constructed for the purpose of this test. The test site selection was made by RMOTC engineers. It is located in Section 10, T38N, R78W near the water treatment plant. This site features a water source and water storage facilities nearby. A new test well was constructed on the site with a total depth of 199'. Large diameter 20" casing was set at 198' and cemented to the surface. Inside the 20" casing are two strings of 4½" diameter casing and one string of 5½" diameter casing. A special wellhead was fabricated, pressure tested to 1,400 psi and certified by High Country Fabrication for the well. The 20" casing used is 94.00#/ft., K-55, Buttress thread which has an internal pressure rating of 2,110 psi.

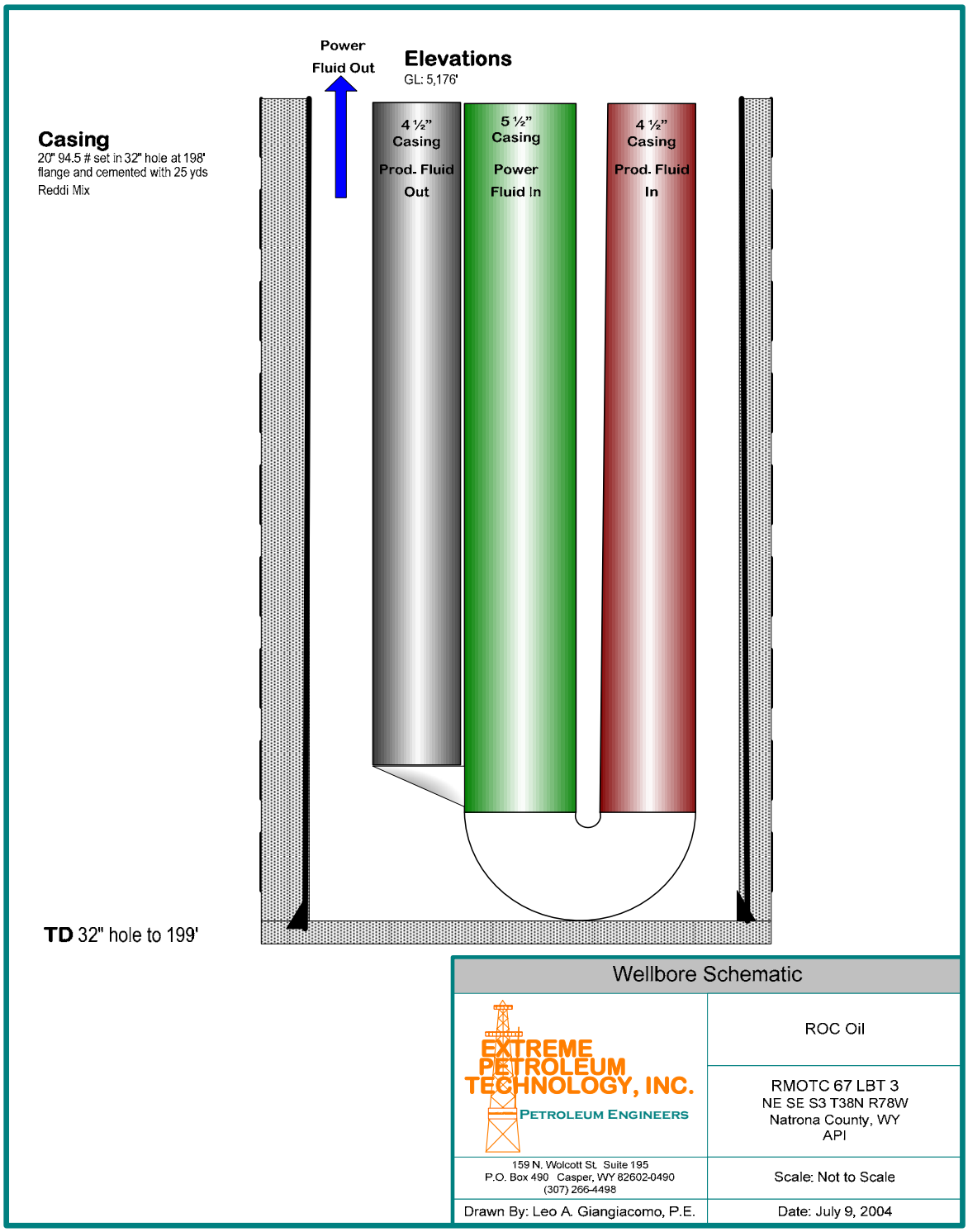


Figure 3. Wellbore Schematic

Test Design

Pre Test Inspection

Prior to conducting the test, the BHA and the lubricator containing the pump were visually inspected for any damage that may have occurred during transportation and handling of the equipment. No damage was observed. Also the test site was inspected to confirm that the surface facilities would meet the requirements for the test and comply with all DOE/RMOTC safety and policy regulations. The inspection was performed by a task force made up of RMOTC, ROC and OHI personnel. All participants were in agreement that the requirements were met and the test could proceed.

Fluids Preparation & Monitoring

The hydraulic pump has specific requirements for power fluid in order to maximize pump efficiency, and maintain a long pump life. The following measurements were developed and recommended by ROC and OHI to simulate the Cliff Head produced water and minimize damage to the pump. Suitable additions were to be made to the fluid to keep within specification.

Property	Specification	Test Frequency
Chlorides	~4000 ppm	Daily
PH	9.2-9.5	Daily
Scale Inhibitor	10 ppm	As required
Corrosion Inhibitor	10 ppm	As required
Suspended Solids	10 ppm@10 µm	Weekly
Sulphite	>10 mg/l	Daily

Daily millipore testing, as per NACE Standard TM0173-99 should also be conducted, to monitor the quality of the fluid. The filters will then be inspected with a hand lens, magnet, and dilute HCl, for the presence of metal and elastomer particles and scale ($CaCO_3$).

Additional measurements will be required, in order to monitor the downhole conditions, such as iron counts (Fe) and turbidity readings.

Pump Efficiency

When considering positive displacements pumps, there are two efficiencies to be considered, volumetric and energy efficiency.

Volumetric Efficiency

The volumetric efficiency will be measured for both the engine and pump end of the PDP. The total volumetric efficiency of the unit is the two efficiencies (engine and pump) multiplied together. In order to determine the efficiencies of the engine and pump ends, we need to record the pump stroke rate and the actual volumes displaced. The actual displacements will be determined from the flow rate meters. We can then use these values to determine the unit volumetric efficiency. The volumetric efficiency can also be calculated directly from the flow rate measurements. The two values should coincide. Any discrepancy will probably be indicative of an error in at least one of the two measurements.

The volumetric efficiency will be determined for the full operating range of the pump at both the beginning and the end of the test. This will determine how the volumetric efficiency changes with stroke rate and time.

Energy Efficiency & Pump Friction Pressure Drop

Energy is lost through the pump, primarily due to friction pressure drop in the power fluid. Logically then, the friction pressure loss is proportional to the pump speed (fluid throughput). Past research has shown this to be exponentially proportional. The energy efficiency of the pump will be important for determining fuel gas consumption and hence the operational expenditures related to this, as well as the maximum operating rates that can be accommodated by the power fluid delivery system at Cliff Head.

Similarly to the data for volumetric efficiency, the data required for energy efficiency should be recorded directly to a computer for accuracy and ease of manipulation. The flow rates will already be recorded, so incrementally, the data requirement is the inlet and exhaust pressures on both the pump and engine sides.

The energy efficiency of a PDP is a function of the stroking rate as the losses are primarily due to friction pressure drop. Hence, the energy efficiency of the PDP is likely to vary with volumetric efficiency, as greater power fluid volumes need to pass through the pump to maintain a constant production rate. The pump testing should attempt to verify this point.

Power Fluid Loss

It is expected that some leakage of power fluid across the piston seals into the produced fluid will occur. Based on OHI's forecast of approximately 1%, this loss rate should be too low for the flow meters that will be used for the testing to measure. It was therefore proposed to determine the loss rate periodically by observing net changes in fluid levels of the power and produced fluid storage tanks.

Pump Capacity

It was recommended that the pump be tested across its full, quoted operating range. Past experience has shown that PDP's perform at their best when operated between 20% and 80% of their maximum rate. The pump testing should therefore determine (confirm) the useful operating range of the pump. The test should be performed at both the beginning and end of the pump testing.

Hydraulic Pump Deployment & Retrieval

Key to the successful deployment of PDP's at Cliff Head will be their ability to be consistently deployed and retrieved hydraulically. As the test well at the RMOTC facility is short and vertical, successful hydraulic retrieval at the test site will not conclusively prove this ability with respect to the Cliff Head wells, some of which are highly deviated. It will however, instil some confidence that the method is viable for this size of pump.

Post Test Inspection

In conjunction with OHI, a complete teardown of the pump, BHA and standing valve assemble (body) should be conducted at the end of the test. All components should be inspected carefully, measured and photographed. Particular attention should be paid to pre-identified problem areas, with respect to erosion, scaling, wear, and fatigue.

Test Setup

The test setup was performed primarily by RMOTC and OHI engineers based on the test design and site selection. This phase involved vendor selection for well work, and coordination that will be primarily RMOTC and OHI's responsibility. Most of the planning and design for equipment layout was done onsite using resources that were at hand.

Figure 4. Test Setup

For the early part of the first stage of testing one 5000 bbl treated water tank was used, then two 5000 bbl tanks were used for the balance of the first stage and during the second stage. One tank was used as a source of power fluid and the other as a source of produced fluid. Schematics for the two stages of testing are shown in Figures 7 and 8. A lubricator containing the hydraulic pump, supplied by OHI, was

shipped to the test site along with a National Model J-275L Quintuplex Single-Acting Plunger pump. Other equipment was purchased locally or provided by RMOTC. A Gardner Denver Model HD2000 pump was leased out by RMOTC for use in the high pressure testing.

Well Head

A special well head was designed to run the test. The well head was designed by RMOTC engineer, Bryant Mook. It has a 5-1/2" thick flange to fit on 20" diameter casing. Three strings run through the well head with two strings having a 4-1/2" OD and one with a 5-1/2" OD, each with its own wellhead. The well head is equipped with a safety valve as well as two 5-1/2" valves on the sides. Pressure tests were run to 1,400 psi prior to test installation. The wellhead flange is attached to the 199' hole by 20 bolts. A diagram of the wellhead is shown In Figure 5.

The tallest wellhead contains the 5-1/2" OD casing that is the inlet source of the power fluid. This well head is colored red in Figure 5. The second tallest wellhead is an outlet for the returned produced fluid. It is shown in blue in the diagram. Finally the shortest wellhead, shown in green in the figure, is the inlet source for the produced fluid. A 5-1/2" valve coming out the side of the wellhead is the source of the returned power fluid. Power fluid leaves the BHA downhole where it then travels up the annulus and is circulated to the power fluid tank.

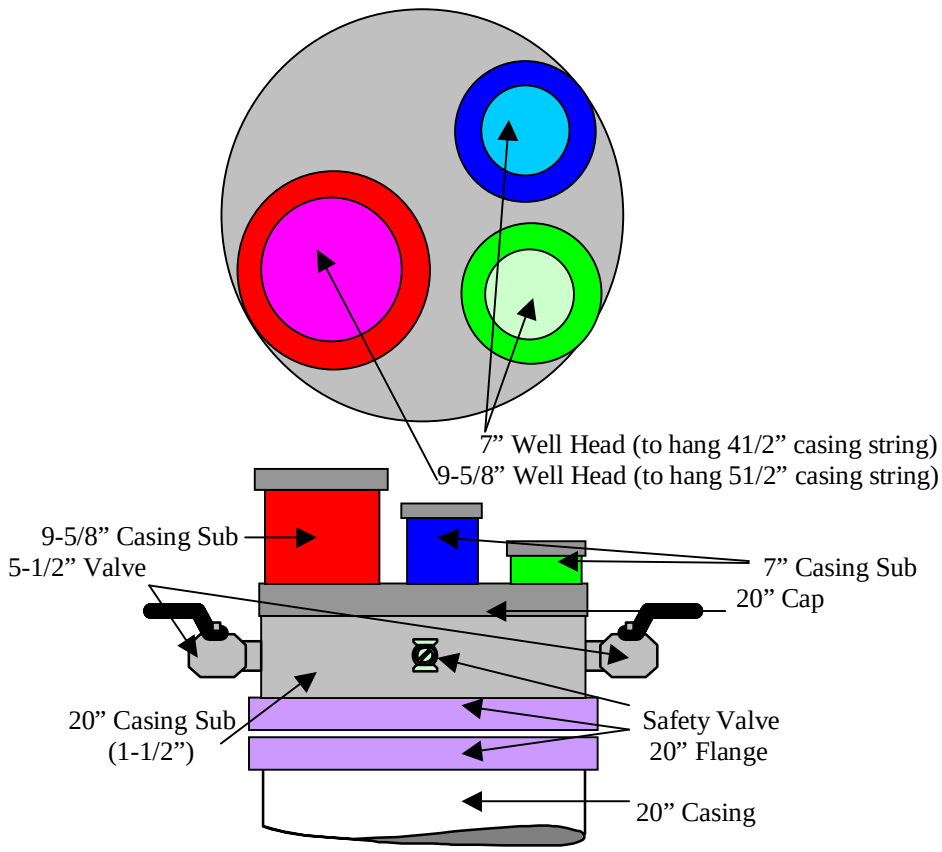


Figure 5. Wellhead Schematic

Figure 6. Wellhead prior to installation

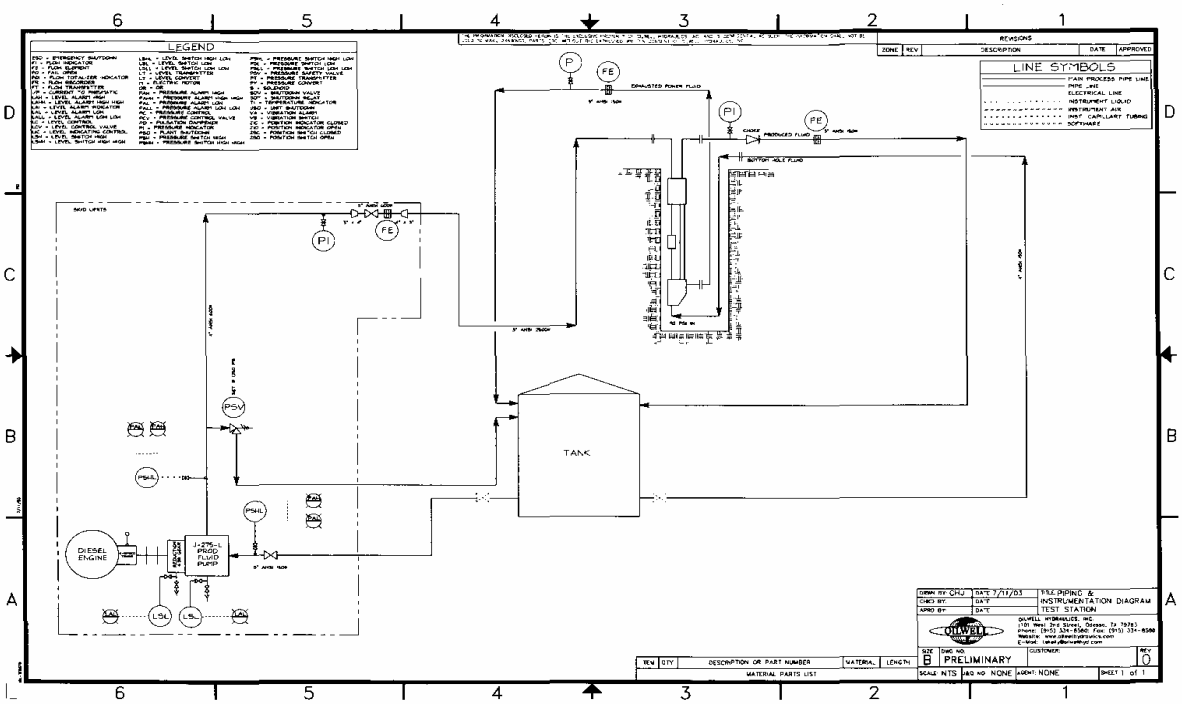


Figure 7. Schematic of test site for first stage with one tank (source: OHI)

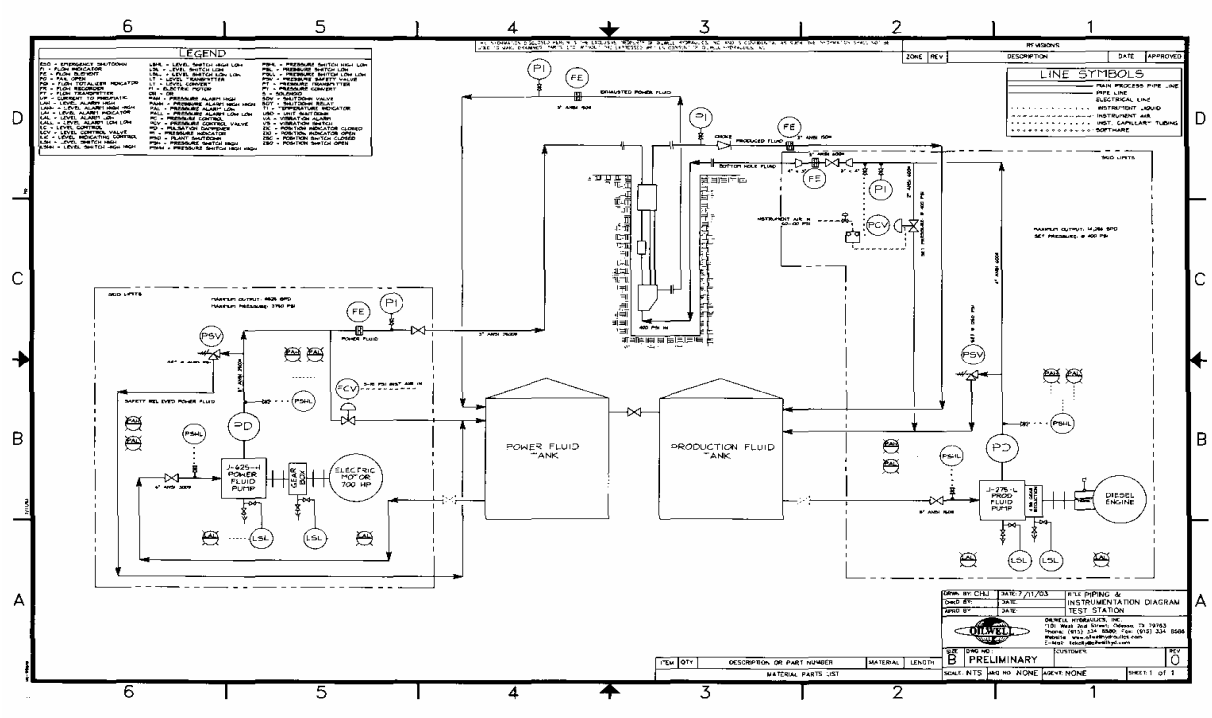


Figure 8. Schematic of test site for second stage with two tanks (Source: OHI)

Surface Pumps

A National Model J-275L Quintuplex single-acting plunger pump with a Caterpillar 3406 Turbo six cylinder diesel engine were provided by OHI to be used to supply the production fluid to the downhole PDP suction. The Caterpillar 3406 engine is rated at 345 HP at 1800 RPM.

Due to vibration problems in the system RMOTC provided a high volume electric motor driven centrifugal pump to use as a replacement for the quintuplex. The centrifugal pump was not effective in reducing the vibration problem. Gravity feed from the production tank was also attempted but was unsuccessful. The quintuplex was then used for the balance of the test.

Production Fluid Pump (National - Quintuplex)

Model	Plungers	Max BPD	Max Press PSI
J 275	3 ½”	14,275	1000

Figure 9. National Model J-275L Quintuplex Pump

A Gardner Denver Model HD2000 triplex plunger pump with a Caterpillar 3508B diesel engine and Allison DP 8962 five speed transmission were provided by RMOTC to be used to supply the power fluid to the downhole PDP. The Caterpillar 3508B engine is rated at 1100 HP at 1800 RPM.

During the first stage of the test a 3 ¾" fluid end and plungers were used. For the second stage the 3 ¾" fluid end was replaced with a 5" fluid end and plungers.

Power Fluid Pump (Garner Denver - Triplex)

Model	Plungers	Max. BPD	Max Press PSI
HD – 2000 Triplex	3 3/4 "	6500	8826
HD – 2000 Triplex	5 "	21000	4965

Figure 10. Gardner Denver HD2000 Triplex Pump

Centrifugal Pump

Figure 11. Centrifugal Pump

Water Tanks

Two 5000 bbl water tanks were used in testing the PDP. The tanks were installed in the late 1980's for use as storage of produced and softened water for steam generation and injection. These tanks have been out of service since the mid-1990's. As a precaution to avoid contaminating and possibly damaging the system, stainless steel screen was installed upstream of the pump GP between the tank and the plunger pump to collect any unwanted debris.

Figure 12. 5000 Barrel Tanks

Piping

High pressure tubing was selected for the pipe running between the Gardner Denver triplex pump and the 5-1/2" well head where the high pressure fluid was present. A working pressure on the tubing of 10,000 psi was selected to exceed the anticipated 3,000 psi test pressure of the fluid to create a safety factor. Rubber hoses were used in the fluid return lines to help in pulsation dampening and to absorb shock from the downhole pump.

A color coding system was devised to indicate the directional flow of fluid through the system. Pipes carrying fluid to the surface plunger pumps from the tanks were painted yellow. Inlet pipes to the wellheads were painted red. This included the high-pressure power fluid as well as the produced fluid supply line. Produced fluid and returned power fluid was delivered in pipes painted blue. All tubing was labeled with tape indicating the direction of flow as well as indicating contents and warnings such as HIGH PRESSURE.

Figure 13. Wellhead showing color coded piping

Figure 14. Color coded piping at test well

Lubricator

A lubricator was used as a delivery and retrieval device for the sub-surface pump. The lubricator for this test was provided by OHI and was shipped to NPR-3 from Odessa, TX. A diagram of the lubricator is shown below.

Figure 15. Lubricator installed on wellhead

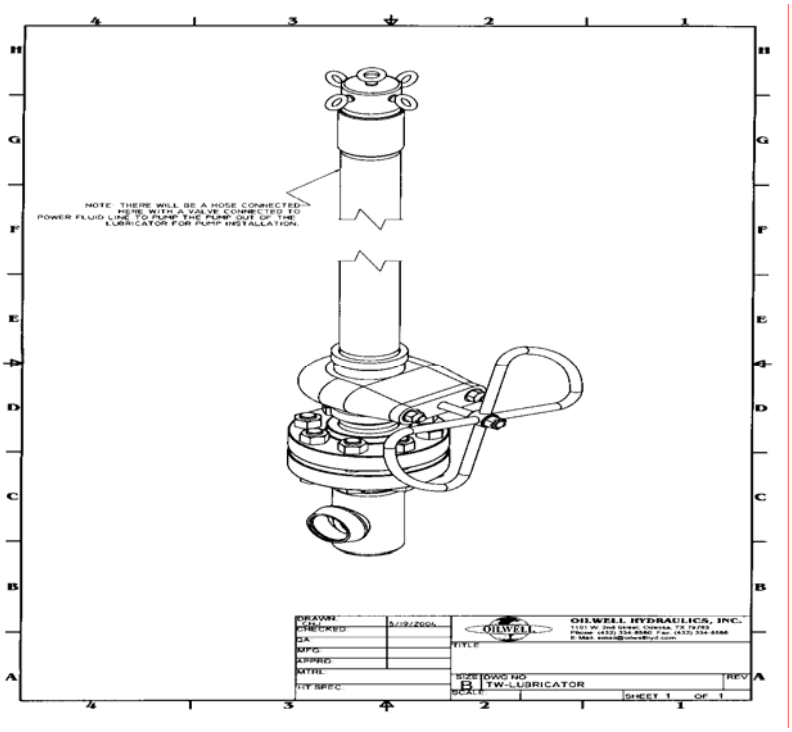


Figure 16. Lubricator schematic (source: OHI)

Chemical Feed System

One of the requirements of the test was to simulate the Cliff Head produced water. For the first stage this was done by adding calcium chloride. At some point near the start of the test the chlorides of the power fluid was raised from the 1040 ppm in the Tensleep supply water to 3340 ppm in a sample taken on 07/27/04. On 08/02/04 another 1½ pallets (approximately 4200 lbs) of calcium chloride were added to the power fluid tank. The chloride concentration increased to 4340 ppm. The first stage of the test was terminated on 08/04/04.

Prior to the start of the second stage of the test, four sacks (200 lbs) of sodium bicarbonate were added to the power fluid tank on 08/18/04. On 08/19/04 the decision was made to dump the power fluid in the system and replace it with new Tensleep water. Nalco Exxon Co. was contracted by OHI to provide analysis of the water being used, potential pump damage and a treating recommendation. The Nalco Exxon recommendation for the second stage is as follows:

1. Start circulating the tank
2. Add 5 gallons of scale inhibitor to the top of the tank
3. Add Sodium Bicarbonate to bring pH up to 9
4. Hook up oxygen scavenger and corrosion inhibitor at different locations
5. Circulate tank for 24 hours
6. Once test starts begin treating oxygen scavenger at 7 gallons per day or 21 ppm
7. Pump 180 ppm corrosion inhibitor for first day or 55 gallons. Then set rate at 30 ppm or 10 gallons /day thereafter
8. Every 5 days add 2.5 gallons of scale inhibitor to the top of the tank

The Nalco Exxon chemicals used were:

Scale inhibitor	EC6485A	15 gallons	
Corrosion inhibitor	EC1317A	165 gallons	3 drums
Oxygen scavenger	EC6064A	110 gallons	2 drums

The corrosion inhibitor and oxygen scavenger were injected into the power fluid stream through individual taps in the line upstream of the Gardner Denver triplex pump as shown in Figure 19.

Figure 17. Containment system for chemicals

Figure 18. Chemical delivery system

Figure 19. Chemical injection point

Instrumentation

To measure the volumetric and pressure conditions, the test circuit included four flow meters to record the volumes displaced and five pressure gauges. The system efficiency is then calculated directly from the flow rate and pressure along with the manual stroke counts. Any changes are then evaluated to determine whether there is a loss of efficiency or measurement error.

Location of the instrumentation is as follows:

Turbine Flow Meter:

Period: 1st and 2nd stage of the test (from 07/23/04 – 09/14/04)

Quantity: 4

Location: Power Fluid Injection flow line (01), Power Fluid Return flow line (01), Production Fluid Injection flow line (01) and Production Fluid Return flow line (01).

Characteristics:

EDD (Electronic Data Devices) Turbine Flow Meter, size 2", flow range 0.9 –9.3 BBL/min, 1300-13000 BBL/Day, Repeatability +/- 0.1% of indicated flow throughout linear range, Linearity +/- 1% of the k-factor throughout linear range.

Performance of the equipment:

During the first test stage the turbine flow meter located in the Production Fluid Return flow line failed due to damages to the internal mechanism. Inspection of the meter indicated the damage was apparently caused by a relatively large metal foreign object in the flow stream.

Ultrasonic Flow Meter:

Period: 2nd stage of the test (from 08/25/04 – 09/14/04)

Quantity: 1

Location: Power Fluid Injection flow line (01).

Characteristics:

Portable non-invasive EESIFLO 6000 Series Inc. with Q3N transducer. The flow measurement is based on the principle that sound waves are influenced by a flowing medium. Measurements are made by penetrating the pipes with ultrasound and subsequently time differences, frequency variations and phase shifts of the ultrasonic signals are evaluated.

This equipment was clamped onto the outside of the power fluid injection line eliminating the need to dismantle the piping and interrupt the process.

Performance of the equipment:

EPT personnel were not on site and did not receive information about the performance of this equipment.

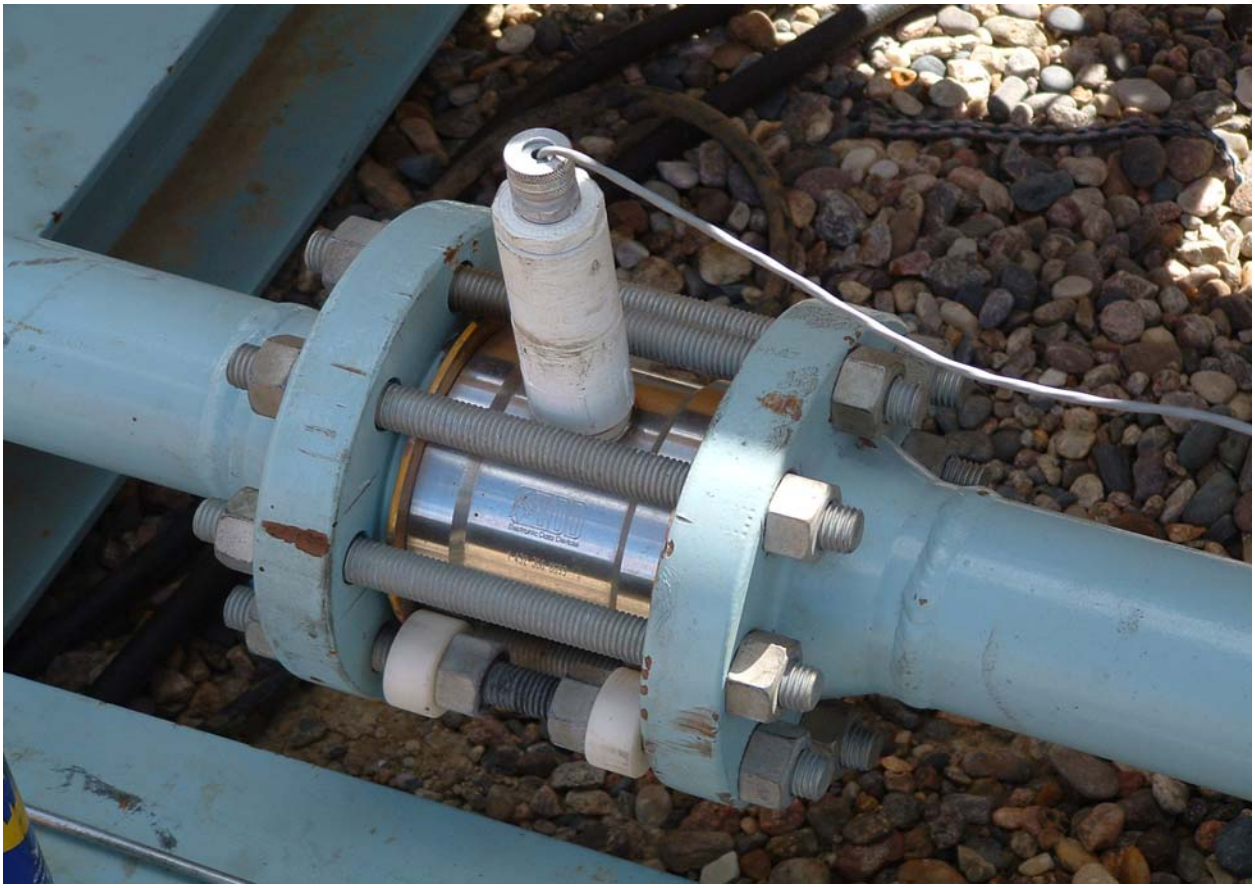


Figure 20. Turbine Flow Meter

Figure 21. Flow meter prior to installation

Figure 22. Panel with flow meter readouts

Pressure Gauges

Period: 1st and 2nd stage of the test (from 07/23/04 – 09/14/04)

Quantity: 5

Location: Power Fluid Injection flow line (01), Power Fluid Return flow line (01), Production Fluid Injection flow line (01) and Production Fluid Return flow line (01), Wellhead (01).

Characteristics:

Range Power Fluid & Production Injection Gauges: 0-5000 PSI, liquid filled.

Range Power Fluid & Production Return Gauges: 0-1000 PSI, liquid filled.

Performance of the equipment:

On 08/03/04 the pressure gauge located in the production line did not drop when the pressure was reduced. A visual inspection found pieces of the gauge were visible inside and screws had come loose inside. It was replaced with a new gauge.

At the end of the second test stage it was found that the produced fluid gauge had again failed. The gauge was leaking oil it had been filled with.

Figure 23. Pressure gauge installation

Figure 24. Flow meter installation

Test Procedure

The following is a high level proposed program that was developed by ROC and OHI and approved just prior to the start of the test.

1. Inspect and prepare downhole equipment.
2. Run completion. Conduct pressure tests as necessary to confirm no tubing/BHA leakage.
3. Inspect and prepare surface equipment. This can be carried out in tandem with steps 1 & 2.
4. Test flow meters. It is recommended that all meters should be calibrated before and after testing and at any time during the test period should an abnormal trend be observed.
5. Test pressure gauges. Similar to 4. All gauges should be calibrated before and after testing and at any time during the test period should an abnormal trend be observed.
6. Connect flowlines and test as necessary.
7. Install pump hydraulically. It is recommended that the pump be retrieved and deployed at this time, to confirm that hydraulic retrieval is possible, for these conditions.
8. Prepare for low rate test.
9. Begin low rate testing. Perform calibration run. Pump should be stroked at various rates from zero to maximum for the low rate test (4000 BPD). The results should be tabulated and the as-new efficiencies for the applicable rates calculated. The calibration run should be performed a minimum of 3 times.
10. Continue low rate testing at 4000 bpd. Record results.
11. Prepare for high rate test.
12. Begin high rate testing. Perform calibration run as per step 9 to maximum pump stroking rate (35 spm) to confirm pump deliverability and volumetric and energy efficiency curves. The calibration runs should be performed a minimum of 3 times.
13. Continue high rate test at 8000 BPD. It is recommended that the power fluid supply rate and pressure be set as appropriate to run at this rate. The test should then be continued at this delivery rate and pressure for an extended period (remainder of test period). Any change in volumetric or energy efficiency that occurs should be very easily observed through a change in pump stroking rate.
14. Conduct calibration run(s). Run pump from zero to maximum rate and record data such that end of test volumetric and energy efficiency curves can be generated. Test should be repeated a minimum of 3 times.
15. Retrieve pump hydraulically. Inspect pump thoroughly, paying particular attention to pre-determined areas. If possible tear down pump for detailed inspections. Record and photograph any problems found.
16. Retrieve completion. Perform visual inspection of BHA, and if possible, tear down for detailed inspection, as per 15.

Test Execution

After being delayed administratively for several months, the pump finally arrived at the test site in early July. Field operations commenced on July 8, 2004.

The wellhead and pump were delivered to the site prior to July 8, 2004. A workover rig was moved on site, and location dirt work proceeded to provide suitable location for equipment setup. The National Q275 quintuplex was set on a gravel pad on sills. The pipe trailer containing the casing to be used for downhole tubulars was spotted in. Equipment for running the completion was being fabricated and/or ordered in for the next day.

On July 9th, a diesel fuel tank was delivered to the site. A casing crew arrived. Berms were built around the location to contain any released fluids. The pump BHA was started into the wellbore. The 5½" casing was drifted to ensure that the pump could be properly deployed. A lightning storm prevented completion of work that day.

On July 10th, the completion was run in the hole, and the wellhead was installed. Casing had to be spaced out to hang in the wellhead, and be properly stung into the seal bore of the BHA. The lubricator was then installed in the wellhead. Lines were hooked up for fluids between the tanks, pump, and wellhead. Much of these lines were rubber hoses. There were several minor leaks that needed to be fixed, but the pump was started up to circulate the hole successfully.

On July 12th, several leaks were fixed. The diesel fuel tank was set and bermed. The National pump was started and the hole was circulated. More leaks were found, the most serious where the 9 5/8" wellhead extension screwed into the wellhead flange. The standing valve was dropped. There was some trouble getting the pump to drop past the valve on the bottom of the lubricator. Diesel fuel was delivered.

On July 13th, the diesel fuel tank was plumbed into the pump. The lubricator was removed, and the leak in the 9 5/8" casing flange was fixed by tightening with a chain wrench. Reinstalled the lubricator and plumbing. The pump was dropped out of the lubricator and pumped to bottom with no problems. The pump was started, but had to be shut down due to movement of connections and lines. The lines were welded to firm supports to prevent connection failures. The pump was then restarted and run for an hour and 15 minutes.

On July 14th, more welding was done to hold down the vibrations in the piping. Overnight rains had flooded the location, and vacuum trucks were required to remove the water. The Gardner Denver HD2000 pump was plumbed in to the test setup to supply higher rate operations. It was decided that all lines should be changed from rubber hoses to steel. The building on the pump was also to be removed to allow the pump to run cooler.

On July 15th through 19th, the berms on the location were redone to increase the holding capacity to that of the two 5,000 bbl tanks. The building was removed from the GD pump. The replacement of lines was started. Calcium chloride was added to the power fluid.

On July 21st, there was a meeting to discuss the startup of the test and review the safety and environmental concerns. Details may be found in the appendix.

From July 28th to August 1st, the pump was operating in test mode near the desired 8000 BPD rate. It became necessary to reduce the rate due to surface equipment problems. There were numerous leaks that developed, and vibrations were considerable, sometimes causing shut down temporarily. On August 1st, the pump appeared to be struggling. The pressure regulator on the produced fluid outlet was found to be damaged.

On August 2nd, 1.5 pallets of calcium chloride were added to the power fluid tank. The fluid rate meter on the production return line was found to be damaged. The #2 pump went down with a damaged pressure control valve. Fluid was feeding into the well on gravity.

On August 3rd, the rate was dropped to 4,000 BPD on orders from Terry Kelly. The fluid levels between the tanks were equalized. The pressure gauge on the production line did not drop when the rate was dropped. The gauge was damaged. A new gauge was installed.

On August 5th, the lubricator was installed. The pump was pumped to the surface in 2 minutes, 21 seconds with 5 bbls fluid. The pump was shipped back to OHI in Odessa, TX for evaluation.

On August 12th, it was found that the power fluid had not been circulated as planned, due to repairs to the Gardner Denver pump fluid end.

On August 16th, The pump arrived from Odessa. The lubricator was installed on the wellhead, and some replumbing work was done until August 19th. It was decided that the power fluid tank should be drained and cleaned over the weekend.

On August 21st, the tank was empty. It was filled with 4 feet of clean water and pumped out. A vacuum truck was used to suck the bottoms off the tank.

On August 23rd, the tank was refilled with clean Tensleep water.

On September 14th, the pump was retrieved. The complete BHA was pulled out of the hole. There was no indication of problems with the threads or a hole in the casing. The seals on the seal bore insert were in good condition. The guide plate had broken off and was left in the well. There appeared to be oil on top the fluid in the wellbore. The tubulars were apparently coated with corrosion inhibitor as planned.

Figure 255. Power fluid inlet sealbore assembly after first stage showing little damage

Once the equipment for this test had arrived on location and prior to starting the test, several modifications to the operating procedure were necessary to carry out the test. This was due to the prototype nature of this set up. This type of test had not been done before and adjustments for dynamic variables were required. Planning for lowering the (BHA) took the most consideration, and that procedure was modified several times.

Finally a decision was made to deliver the BHA downhole by running two strings simultaneously. Elevators lowered the BHA by switching back and forth between 4-1/2" casing and 5-1/2" casing. After

the BHA had reached the bottom of the hole the other 4-1/2" string was lowered and stabbed into the BHA. After completing the BHA delivery the well head was placed onto and attached to the flange.

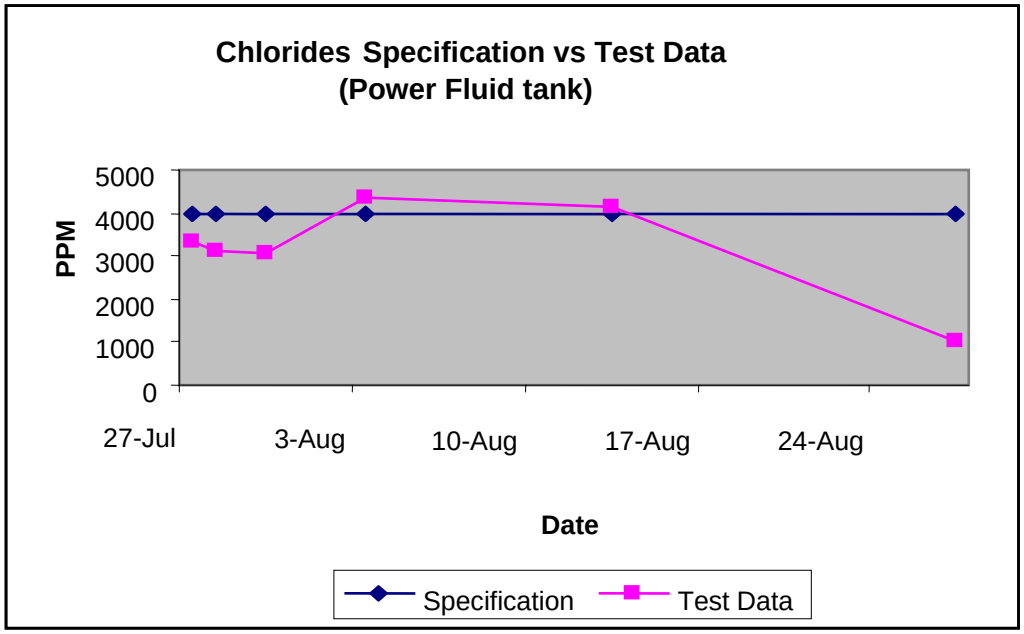
After setting up the system and ensuring the system had no leaks, the test was run to see if the down hole hydraulic pump could be pumped down to the BHA. Initially the pump did not successfully go down hole. However, after removing the lubricator it was discovered that the pump was stuck in the lubricator valve. The valve had not been completely opened. The system was re-connected, the pump hydraulically raised to the top of the lubricator and the valve was opened all the way. Once the system was properly set up the delivery of the hydraulic pump to the BHA was successful.

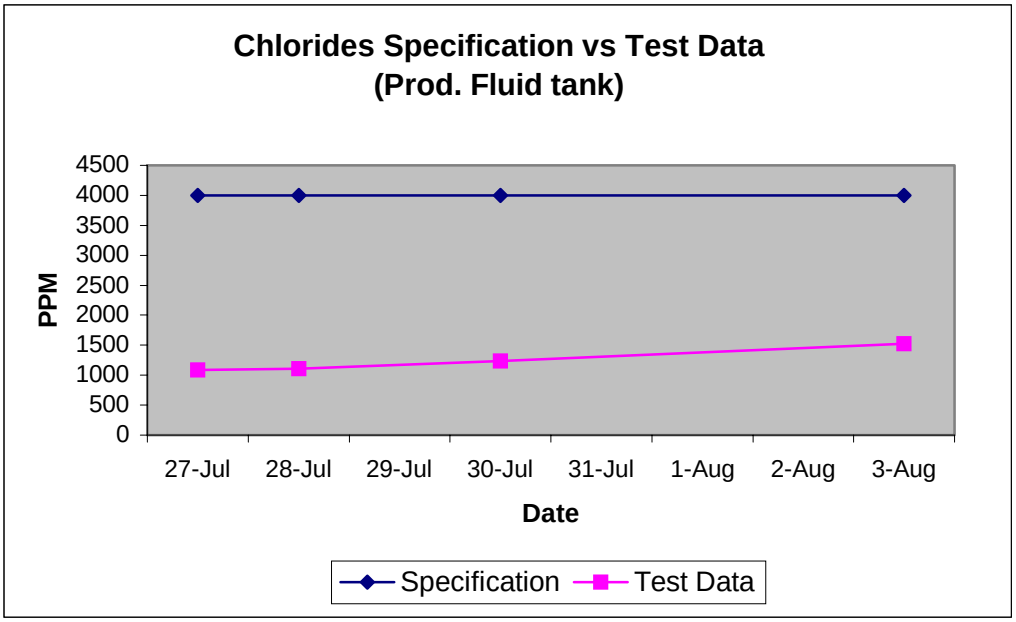
This procedure was done at low pressure to test for any leaks in the system. Initially there were some problems with leaking but these were fixed by tightening some loose joints in the piping and by tightening the wellheads.

Once the system was properly put together we began our high pressure testing using the Gardner Denver pump.

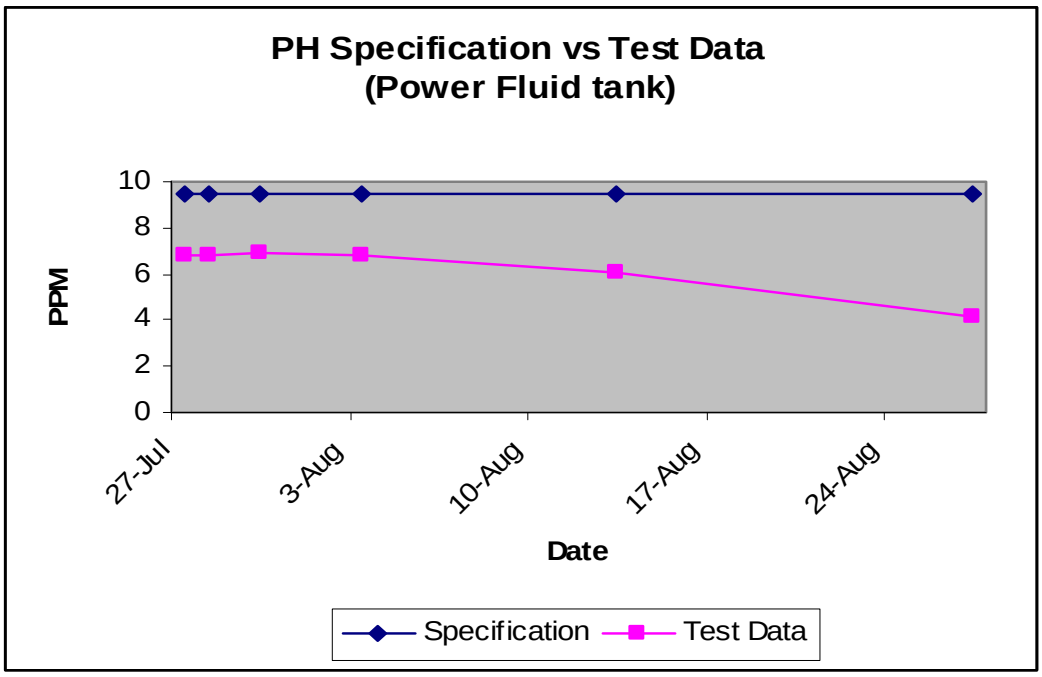
While the piping for the system was being put together the 5000 bbl tanks were filled with water provided by the RMOTC Tensleep wells. Calcium chloride and sodium bicarbonate were added to help replicate conditions at the Cliff Head Field. The initial quantity of calcium chloride is not known but the chloride concentration was raised from 1,040 ppm to 3,340 ppm. On 08/03/04, another 4,200 lbs of calcium chloride was added to the power fluid raising the chloride concentration to 4,340 ppm. The chloride concentration of the water was addressed in the first test stage but the pH value of the water was not. As a result the water did not reach the specified 9.5 value. The dry chemicals were added to the system by dumping them in the top of the 5,000 bbl power fluid tank.

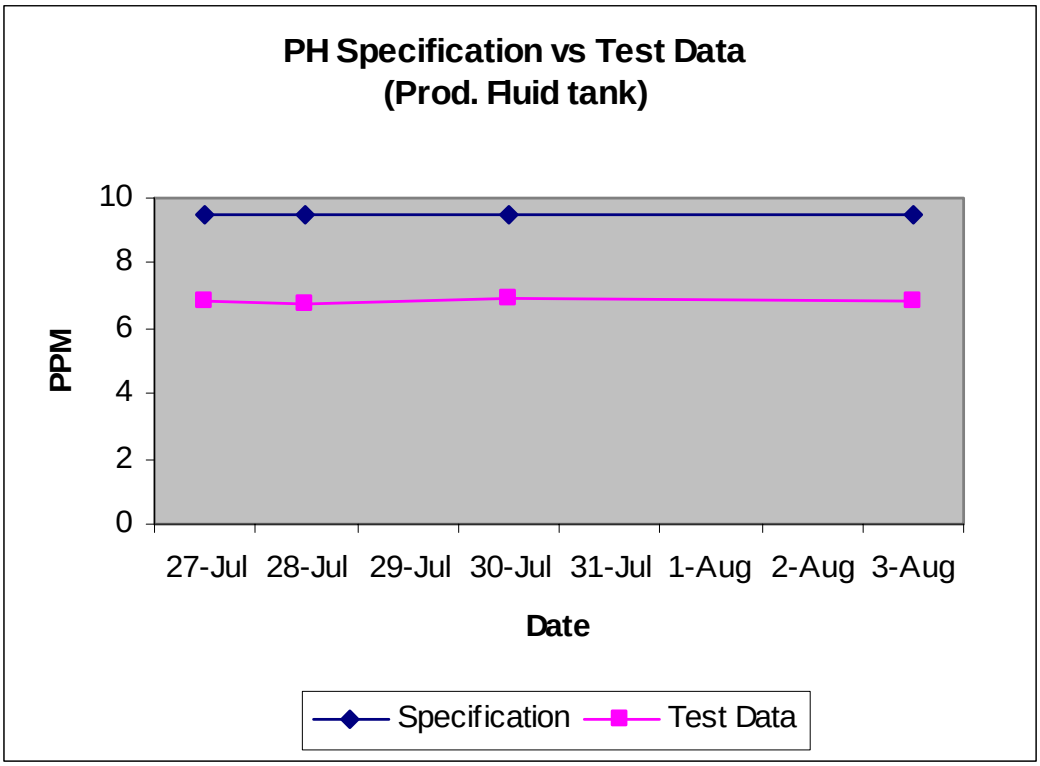
Prior to the start of the second test stage 200 lbs of sodium bicarbonate was added to the power fluid. This apparently raised concerns about the scaling tendency of the power fluid so the power fluid tank was emptied and refilled with new Tensleep water for the second test stage. An analysis of a power fluid sample taken 08/27/04 indicates no chlorides had been added to the water. The Exxon Nalco chemical program to address corrosion and scale formation was used during the second test stage.



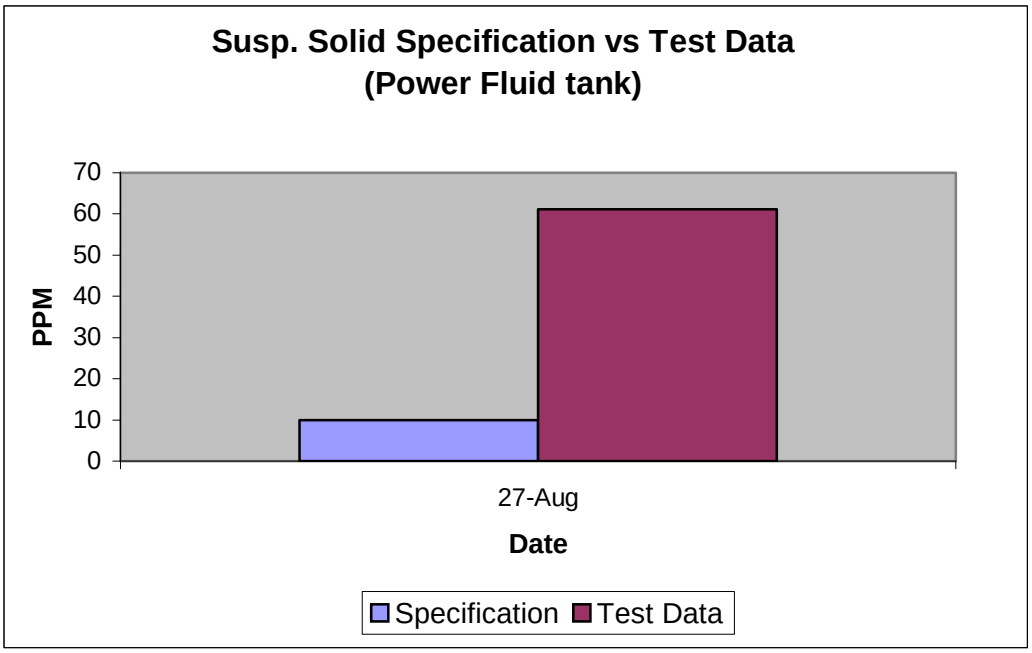


The pH specification was never maintained during the test. The pH of the power fluid in the 08/27/04 sample was that of spent acid.





Solid Suspension was only measured once during the test. The results demonstrate the water used had a high ppm of suspended solids relative to the specifications.



After the BHA was in place and piping was set up to connect the system the first stage of testing began. During the start of the first stage of testing only one water tank was used. The water from this tank was used as a source of both power fluid and produced fluid. It was not necessary to differentiate between these fluids for the early part of the first stage of testing. A low pressure test was done to check for leaks and to ensure that the system was set up properly. Once all of the leaks had been repaired and all of the tubing was in the correct place, the hydraulic pump was pumped into the BHA for operation

For the balance of the first stage and the second stage of testing it was necessary to differentiate between the power fluid side of the system and the produced fluid part of the system. For this stage of testing both tanks were used. By checking the tank levels it was possible to identify any fluid exchange between parts of the system. During this test both the National J-275 and the Gardner Denver surface pumps were used. The J-275 was used to deliver produced fluid to the BHA. The Gardner Denver was used to supply power fluid for running the hydraulic pump.

When the Gardner Denver pump began operating there was excessive vibration in the system due to the hydraulic pump's operation. Supports were added to the pipes coming out of the wellhead and flexible tubing was added to the inlets of the 5000 bbl tank to reduce the vibration.

The system was run at several different flow rates so that friction losses could be calculated. During this process the system did not exceed a pressure of 500 psi. Once the friction losses were calculated an extended run was done at 1000 psi to calculate the efficiency of the pumps and motors. Fluid loss was also calculated and observations were taken to see if there was a fluid exchange between the power fluid side of the system and the produced fluid.

The pump was run over several different pressures and volumetric flow rates. During this stage data was collected from sensors throughout the system. Leakage between the power fluid side of the system and the produced fluid side was observed to be the correct amount for lubrication of the system.

NOTE: Information on the detailed assessment of the PDP after the first test stage tear down was provided by Bob Cook (ROC). The tear down and assessment was performed at the OHI Odessa facility. There were no EPT personnel present. The following list of assessment findings are from the email received from Bob Cook (ROC) dated August 11, 2004:

> - There is no reason mechanically for the witnessed efficiency drop based on the tear down of the pump at the OHI facility. The only conclusion which can be made is that the change in efficiency is attributable to a general decline in the metering measurements as a result of their progressive failure.
>
> - There is no damage to the suction and discharge valving: "pump end valving is in as new condition"
>
> - There is minor wear on the middle rod area which is believed to be a result of the chemistry of the power fluid (CO_2 and/or H_2S) attacking the chrome plating and exacerbated by inadequate lubricant properties of the power fluid. Nalco has been given latest power water analysis and will provide a recommendation to eliminate oxygen and arrive at appropriate additives to improve lubricity and corrosion issues. The appropriate chemicals will be added to the power fluid prior to re-start of the test (expected to be Monday 16th August) and it is expected that on going batch dosing may be necessary. The longer term solution to these problems would be to use nitride rather than chrome coated rods. This solution was used in the Guppco field in Egypt and may be a wise specification for Cliff Head if we believe corrosive elements could arise over field life.
>
> - The damage to the 3rd seal occurred on 29th July when the Gardner Denver triplex (power fluid pump) shut down with a fuel problem. With the National

quintuplex (production fluid suction) still operating, the suction pressure would have been greater than the power fluid pressure which would have been sufficient to rapidly unseat the PDP and thereby cause the damage to the seal. The fix during future testing operations at RMOTC will be to include an auto shutdown device between the G-D pump and the National such that if the G-D pump goes down it automatically takes down the other pump. Note that this could not happen in the real life Cliff Head situation as there is no production suction pump in the Cliff Head system... the one in the test system is to allow simulation of Cliff Head suction pressures and pressure differentials.

- Inspection of the produced fluid discharge line meter turbine by the vendor has established that "something solid had gone through the meter" thereby damaging it and resulting in improper readings. The measured efficiency drop is now considered to be a result of incorrect meter performance. It is suspected that weld slag or equivalent when flushing and/or testing the system, may have damaged the meter.

- The other meters have yet to be calibrated but the decline in pump end efficiency based on only the produced fluid suction line meter is expected to be attributed to a deterioration in this meter rather than a decline in the pump's performance. A pulsation dampener is to be added to the National pump (produced fluid) which should help smooth flow through the produced fluid meters.

- The Fisher back pressure valve was poorly sized for its duty and the controller was malfunctioning. This was causing the erratic slugging effect on the suction side of the pump. It also didn't help with the metering.

For the second phase of the test OHI personnel arranged for oxygen scavenger and corrosion inhibitor injection into the power fluid suction line. Apparently there was no effort to simulate the Cliff Head power fluid. Tensleep water with only the treating chemical was used.

The power fluid tank was cleaned but wasn't cleaned in the right manner. When the BHA was pulled there was oil on top of the fluid inside the 20" casing.

EPT was advised that Jason Jordan would be the onsite witness of the test after 8/24/04. EPT received little information from that point forward until contacted by Jason on September 13, 2004. The test was being terminated at that time due to an inability to get good flow rate measurements and determine pump efficiencies. EPT was requested to witness pulling of the tubulars and BHA on September 14, 2004.

Figure 266. Oil on top of well while pulling pump

Figure 27. Bottom Hole Assembly pulled after test showing missing guide plate

Figure 28. Bottom hole assembly being laid down after test

After the tubulars and BHA were pulled there were questions related to the future status of the test and onsite equipment. It was decided to anticipate a future resumption of the test. To be ready, the tubulars were to be put on racks, all lines drained and the power and production pumps winterized and left on location.

Discussion and Analysis

The Gardner Denver triplex (power fluid pump) experienced at least two unscheduled shut downs during the test. On July 26, 2004 the bladder in the pulsation dampener failed and had to be replaced. Then the engine went down on July 29, 2004, with a fuel supply problem. The shut down due to the loss of fuel resulted in the downhole pump being unseated and damage occurring to the third seal on the downhole pump. There were daily shut downs for scheduled maintenance and service of the pump.

One day after the pump shut down due to loss of fuel, July 30, 2004, problems started with the readings from the production return line meter. The meter started reading much higher than the production inlet meter volume. Then on August 1, 2004, the meter essentially quit working. Inspection of the meter turbine by the vendor has established that "something solid had gone through the meter" thereby damaging it and resulting in improper readings. In conversation with the vendor, it was stated the damage observed was similar to damage that had been observed in other meters where a relatively large foreign object had passed through.

Corrosion observed in the pump following the first stage can likely be attributed to the chemistry of the power fluid (CO_2 and/or H_2S) attacking the chrome plating. Based on the pH measurements of the power fluid it did not match the specified value and was very slightly acidic. Also from the Nalco Exxon review the water had a scaling tendency which could have caused problems with the pump. For the second stage of the test Nalco Exxon provided a recommendation and chemicals to eliminate oxygen and arrive at appropriate additives to improve lubricity and reduce corrosion problems.

From information received following the pump tear down following the second test stage the chemical treatment was successful and there was no damage to the pump.

Based on the information received on both pump teardowns, there does not appear to be a mechanical reason for the observed efficiency declines. Instead the decline in calculated pump efficiencies is very likely due to problems that occurred with the meters and pressure gauges and not to pump failure.

Several conditions could have contributed to the pump rod damage observed following the first test stage. These include the slightly acidic condition of the fluid, suspended solids in the fluid, scale formation, low fluid lubricity and cavitation. Essentially the general fluid conditions were not ideal. Another contributing factor for the rod failure may have been a poor chrome-plating job.

Figure 29. Pulsation Dampner

There were signs of pitting corrosion.

Figure 30. Pump showing pitting corrosion

Figure 31. Inside of Lubricator

The power fluid was run through Millipore filters to check for fines. There was a fine reddish film on the filters but no sign of metal or rubber was visible.

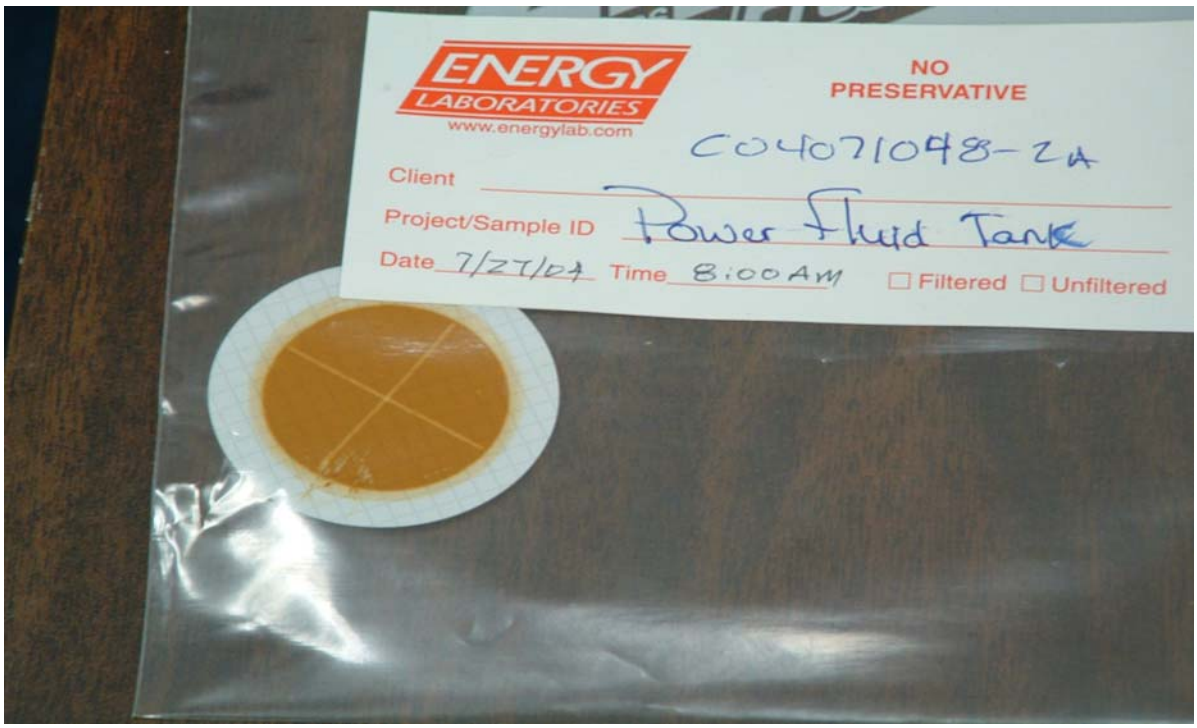


Figure 32. Millipore Filter

Conclusions

Test Execution

NOTE: The test was conducted in two stages. The first stage ran from July 23, 2004, to August 4, 2004. The pump was then retrieved and shipped to Odessa, TX for tear down and evaluation. There were no EPT personnel on site for the second test stage. It is understood the test was started on August 24, 2004, and terminated on September 11, 2004.

1. The designed wellhead, with the exception of the initial make-up problem on the 9-5/8" casing, worked well and met test requirements.
2. The National quintuplex and Gardner-Denver triplex pumps were adequate for the test.
3. The lubricator worked successfully.
4. The vibration and pressure surge problems affected all parts of the system resulting in numerous line leaks and equipment failures, i.e. – pressure gauges, flow meters and back pressure regulator.
5. Numerous line anchors were used with very limited success to eliminate movement and vibration of the various lines.
6. Tie downs were attached to the 20" wellhead to keep the 5½" and 4½" casing in the well and eliminate vibration.
7. Though liquid filled gauges were used and attempts were made to dampen the pressure surges they were not adequate to prevent failure of the gauges.
8. Suspended solids caused problems with the operation of the turbine flow meters.
9. With the shallow test well and resulting low volume of pressured fluid, high fluid rates and three positive displacement pumps in use, there was not enough pulsation dampening equipment included to prevent vibration.
10. There were delays in the start up of the test due to changes required to come into compliance with DOE/RMOTC Environmental, Safety and Health rules.
11. At times there was an appearance of confusion over who was ultimately directing execution of the test – OHI, Roc Oil or RMOTC.
12. Failure to adequately clean the 5,000 bbl tanks resulted in excessive suspended solids during the test.
13. It was not possible to run the test on a continuous 24 hour basis due to daily shut downs for service requirements on the Gardner/Denver pump.
14. The measurement of force to pull the pump through curved tubulars was not performed at the RMOTC test site.
15. Beyond the running of the BHA and tubulars no fit test was performed at the RMOTC test site.
16. Establishment of procedures and time estimates was an ongoing activity as the test progressed. Procedures were developed for handling and running the BHA, landing and spacing out the 4 ½" produced fluid inlet casing and deployment of the PDP into the BHA. The workover/tear down of the PDP was performed in the OHI facility in Odessa, TX. There was no attempt made to retrieve the standing valve following the first test stage.
17. Various design issues listed in Item #10 of the "Test Objectives" section of this report were also to be concluded. EPT personnel were not present at the PDP and BHA tear downs and evaluations performed in the OHI facility in Odessa, TX and can not comment on many of those issues since no information was received. Following the first test stage there was concern about the metallurgy of the rod pump. The rod used had been chrome plated. Minor

wear and corrosion was found on the rod. This was believed due to the presence of CO_2 and/or H_2S in the power fluid and the lack of lubricity of the fluid.

Fluid System

1. The original specifications to use a test fluid similar to the Cliff Head water were never attained.
2. Calcium chloride and sodium bicarbonate was added to the power fluid during the first stage of the test and the chloride concentration was near the desired 4,000 ppm.
3. EPT personnel were not on site for the second stage but from the one sample analysis received no chlorides were added to the power fluid during that stage.
4. The specifications for pH and suspended solids were not addressed.
5. The reported pH for the Tensleep water was 7.08.
6. The objective pH was 9.5 but the highest recorded for the power fluid was 6.91 during the first stage.
7. During the second stage, the sample analysis received showed a pH of 4.1.
8. From the information available, the only reasonable explanation for the pH to go from the 7.08 of Tensleep water to 4.1 would be the presence of bacteria in the system.
9. The objective suspended solids content of the fluid was 10 ppm maximum. This property was measured once during the first stage and once during the second stage. In the first stage the produced fluid had 66.7 ppm and in the second stage the power fluid had 61.2 ppm.
10. Dumping of the calcium chloride and sodium bicarbonate into the top of power fluid tank to raise the chloride content was inefficient.
11. Prior to the start of the second stage OHI worked with Nalco Exxon to develop a chemical program to protect the pump. This system apparently was successful as no damage or scale formation was reported after inspection of the pump.

Pump and BHA

1. During the first test stage the pump was operated near the desired 8000 BPD and 4000 BPD rates. The duration of the test (8 days) and accuracy of the data was limited by the failure of the surface measurement equipment.
2. Based on the surface measurement equipment the pump operated as specified during the first test period.
3. Efficiencies were calculated but were not reliable due to problems with flow meter and pressure gauge accuracy caused by vibration and pressure surges.
4. The quantity of power fluid leakage into the produced fluid could not be determined due to problems with flow meter accuracy and the transfer of fluid between tanks.
5. The pump was hydraulically deployed and retrieved successfully.
6. Corrosion and/or erosion of the rod pump were found when the pump was inspected following the first test stage. According to Nalco Exxon scale formation was the primary problem.
7. The guide plate was missing from the bottom of the BHA when it was pulled from the hole at the end of the second stage of the test.

Recommendations

1. There needs to be improvements in both pressure monitoring and flow measurement. This should be possible with better pressure gauges, placement of the gauges and dampening of the pressure surges along with better stabilization of the piping to minimize vibration. Pressure gauge systems are available that are designed to operate with positive displacement pumps without failing. Also there are flow meters that function on the Coriolis Technology principle (i.e. Micro Motion Model D150 or D300) that should operate under the test conditions - high volume, pressure, suspended solids, vibrations and pressure surges. These meters can be placed in the same locations as the turbine meters.
2. Develop a spreadsheet with the most important parameters (chemicals used, fluid analyses, pump efficiency, pressures, flow rates, fluid level in tanks, mass balance, operating time, stroke rates of surface and down hole pumps) for monitoring the test in an effective manner.
3. Too many people appeared to be involved in project supervision. There needs to be one person onsite who is in charge and directing the test.
4. Assure the facilities are clean before starting the test.
5. Better equipment (blender or hopper) to assure the correct mix of the dry chemicals.
6. There needs to be coordination with a chemical company to obtain the desired water specifications while also controlling corrosion and scale formation.

Appendix

Daily Reports

OHI/RMOTC Test Daily Report 7/7/04

Meeting with RMOTC, OHI, ROC personnel in Casper. Discussed project procedure, equipment required and personnel needs with emphasis on safety and environmental considerations. Discussion about test procedure.

OHI/RMOTC Test Daily Report 7/8/04

10 AM Visited test site. Photographed wellhead. Discussed completion with Jason Jordan and Bob Matson concerning running three strings of casing into well.

11:00 AM Build pad and gravel for setting National Q275 quintuplex pump. Haul in pump.

1:30 PM Fabricate two plates for hanging 4.5” and 5.5” casing on 20” wellhead.

2:00 PM Haul in casing from pipe yard. Plumb up line to 5000 bbl tank to fill with Tensleep water. Photograph wellhead plates, pump.

2:30 PM Set National pump on sills, align with tank outlet for 8” x 12’ inlet hose.

3:00 PM Spot in pipe trailer. Hook up intake hose to National. Rig up floor on workover rig. Start filling 5000 bbl tank with Tensleep water.

3:30 PM Install pump inlet hose from tank to hose. Build ramp for pipe trailer. Waiting on casing crew with power tongs. Will not be available until tomorrow.

4:30 PM Haul in lubricator with pump. Spot in pipe trailer. Offload 5 ½” casing.

5:00 PM Shut down for night. Plan to run completion in morning. Let tank fill overnight.

OHI/RMOTC Test Daily Report 7/9/04

11:00 AM. Diesel tank (10,000 gallon capacity) delivered to site this morning. Still needs to be spotted. Casing crew on location. No rig crew on site. Took photos of National pump intake, casing trailer on location, rig floor.

12:00 PM Rig crew arrived on location. Found oil on bottom valve on tank. Believe it stuck in valve as tank filled. Rig up casing crew.

1:30 PM Mike Taylor requested berms be build around location. Got backhoe operator out to complete. Picked up pump into derrick. Remove from I beam support.

2:30 PM Completed building berm. Removed I-beam and lowered pump 80% into hole. Set on plate on wellhead flange. Photographed pump on way into hole. Photographed drift tool.

3:15 PM Completed making up first joint of 5 ½” casing. Starting to make up 4 ½” joint into U section of pump BHA.

4:00 PM Completed second set of joints. Now halfway in the hole. Shut down for lightning storm.

4:30 PM Shut down for night.

OHI/RMOTC Test Daily Report 7/10/04

7:00 AM Run last two joints of 4 ½” and 5 ½” casing. Space out joints for wellhead.

9:30 AM Rig down casing crew. Install wellhead.

10:30 AM Make up seal assembly on bottom of 4½” casing and run into hole. Space out and sting into sealbore assembly. Picked up 3 inches and worked back into PBR.

12:30 PM Pick up on 5.5" string and set in slips in wellhead. Set both 4.5" strings in slips in wellhead. Install bull plugs in 2" openings in wellheads.

1:00 PM. Rig up lubricator with full opening valve. Tighten bolts on 20" wellhead.

3:30 PM Rig up lines from tank to pump to wellhead and back to tanks.

6:15 PM Open tank to pump inlet. Several minor leaks. Start up pumps and circulate hole.

7:15 PM Shut down for night.

OHI/RMOTC Test Daily Report 7/12/04

10:15 AM Fixing leaks in various flanges & connections. Replaced some gaskets.

10:45 AM Terry Kelly ordered diesel for National pump w/ Cat engine. Checked temperature of water in tank at 144 deg F. Bermed around diesel tank.

12:30 PM Moved in DOE Stinger truck w/ extra fuel tank so could start pump until fuel from Casper arrived.

1:00 PM Started National pump w/ Cat engine. Circulate well.

1:30 PM Several leaks on wellhead. Turned pressure relief valve so faced downward. Main concern is with leak around where the 9-5/8" extension is screwed into the collar on the wellhead flange. Discussion of how to proceed considering the leak. Decided to go ahead and drop the standing valve and the pump. After get test that the pump will stroke then can repair the wellhead leak before starting the production test.

2:15 PM drop standing valve.

2:45 PM Open main valve on lubricator to drop pump. Had both pressure bumps and surges at 2:55 PM and 3:05 PM but no indication of the pump action.

3:10 PM Shut down pump to pull lubricator to check if the pump was hung in the valve. Pump was hung in the valve.

3:30 PM Lay down lubricator to attempt to free pump. Found that the weight of the pump was binding the gate valve so that it couldn't be fully opened. Stood lubricator nearly upside down to get it out of the valve and then closed the valve. Nipple lubricator back up on wellhead.

5:00 PM Secure well and shut down for night. Fuel truck with diesel arrived.

OHI/RMOTC Test Daily Report 7/13/04

8:00 AM Removed 4" 100# WP hose from well & installed 4" valve to pressure up well. Plumb in diesel fuel tank.

8:30 AM Started pump & checked lines. Found that the produced fluid inlet string was not stabbed into the BHA. RD lubricator and removed wellhead fittings & lines from 5-1/2" & 2 – 41/2" strings. PU 4-1/2" pup joints to lower string. String was lowered 8" below previous setting. Appears to be in receiver.

10:00 AM PU on 5-1/2" & lifted all 3 strings to take weight off slips. Used chain tongs to tighten 9-5/8" casing in wellhead flange. Made up 3 threads. Checked produced fluid inlet to confirm it was stung into BHA. Checked OK.

10:30 AM Reset slips on all three strings and packed off. Hook up wellhead connections.

11:15 AM Pressured well to 400 psi to lift pump up into lubricator. All casing strings moved up 6" due to fluid lift. With pump raised in lubricator opened master valve. Pump dropped @ 11:35 AM. Pressured lubricator to help pump to bottom. On bottom pumping at 11:40 AM. Pump at slow rate. Shut down at 11:47 AM due to movement of connections & lines.

11:50 AM Wait on welder and build supports.

1:30 PM Moved "I" beam to use as base for supports. Welder went to get parts.

2:15 PM Build support for production return to tank and for lines into tanks.

3:15 PM Start National triplex pump and test of down hole pump. Had following readings:

Time	Power	Prod	Diff Power	Diff Prod	Ratio
3:33	125	166.2			
3:38	143	188.1	18	21.9	1.216
3:48	179	234.9	54	1.272	68.7
3:53	216	281.1	91	1.263	114.9
4:08	241	312	116	1.266	146.8
4:30	290	377.2	165	1.278	211

4:30 PM Secure well and shut down for night.

OHI/RMOTC Test Daily Report 7/14/04

7:00 AM Wait on crew

8:00 AM Welder fabricating brackets on I beam to support wellhead hoses. Welded bracket to 5000 bbl tank to hold riser to top of tank. Rig crew preparing to plumb in the Gardner Denver HD2000 pump.

9:00 AM Vac truck sucking out water accumulated on location from rain. Planning rig-up of Gardner Denver pump. Planning to change out all hoses to hard lines.

10:00 AM Discussion on pump size. Gardner Denver is 3.5" plunger with 8" stroke that will run up to 80 rpm. It should be adequate to provide 8000 BPD. The location of the pump was discussed. It was to have the building removed in order to run cooler. The rig hands started removing the building from the pump.

2:00 PM Still removing building. Left for day.

OHI/RMOTC Test Daily Report 7/15/04

10:00 AM Arrive on site. Backhoe removing berm between well and tanks. To replace with berm around 2 – 5000 Bbl tanks & location w/ runoff to 10,000+ Bbl containment pit. Working on removal of building on Gardner-Denver pump skid. Preparing wellhead for hardline connection.

1:00 PM Continue with berm, building removal and wellhead hook-up. Left for day.

OHI/RMOTC Test Daily Report 7/16/04

9:30 AM Arrive on site. Building removed from pump skid and pump spotted. Good portion of berm in place. Working w/ both a backhoe and Bobcat. Welder working on the hard line tie-ins.

Calcium chloride to add to power fluid delivered to the field.

10:30 AM Continue to work on berm and tie-in of well, tanks and pumps. Left for day.

OHI/RMOTC Test Daily Report 7/19/04

10:00 AM Called Dave Hoyer to check on project status and activity. Said that they are still working on the hardline tie-ins and filling 5,000 bbl power fluid tank with Tensleep water. Does not anticipate will start pumping until Wednesday, July 21st. Said that Bob Cook, Jason Jordan, Terry Kelly and Bill Summers are on location.

OHI/RMOTC Test Daily Report 7/21/04

8:55 AM Arrive in field to attend JHA meeting to prepare for start of test. Several people in attendance. The following are some of the items addressed:

24 hr/day - 7 day/wk schedule. One operator will be Toby. Rest not named

3,000 psi maximum desired power fluid pressure

1,250 psi maximum WP on 20" flange

1,000 psi maximum back pressure on return fluid – pressure relief valve set 950 psi

1,500 psi maximum back pressure on production return

Bleed pulsation dampener down to 1,200 – 1,500 psi

Whipstops on all chicksan connections. May not need due to short line sections

Pressure test lines and pressure relief valves to 200 psi above planned maximum operating pressure

Test relief valve on Gardner/Denver pump with 2,750 psi nail then replace with 3,200 psi nail for operations

Stake down lines

Build support at wellhead for return lines

Plan to RDMO rig tomorrow. Have cables to hold lubricator in place when rig is gone

Remove relief valve on power fluid return and have tested at the Gas Plant to 950 psi

Tanks will be gauged on regular basis, each hour initially, to insure no overflow

Install muffler on engine on GD pump

Need either light towers or install lights on top of tanks as needed

MI rig safety house for operating personnel to use

Long discussion on how best to provide fuel for the GD pump engine. Settled on using the day tank and filling as required

Put high & low discharge pressure Murphy switches on the GD pump

Use a project Log Book & keep on site.

10:30 AM Went by wellsite. Lines painted. Installing muffler.

11:00 AM Left field.

OHI/RMOTC Test Daily Report 7/22/04

All the pending activities were completed to give beginning to the

Test, bellow the activities most relevant:

- Leaks in the pipes were fixed.
- Fail in safety valve was fixed in the Triplex pump.
- Pressurized the system.
- Started shipping water to test the system.

OHI/RMOTC Test Daily Report 7/23/04

2.40 PM Start circulating 1250 RPM, ran up to 1360 RPM. Late start today because Critique personnel had been adjusting vibration pipes.

3.30 PM Shut down to change out a faulty valve and decrease pulsation dampner pressure to 840 psi. Upon removal of guard, no pressure was seen on gauge and attempts to fill with nitrogen failed. Hole in the bladder is likely cause.

OHI/RMOTC Test Daily Report 7/24/04

07:00 AM Discharge line off of wellhead starting to leak.

07:30 AM Reset flow meters.

09:42 AM Shut down operations for services

10:02 AM Resume operation. Pump on line 1250 RPM.

05:00 PM The engine side rod packing was leaking a litter water, tightened packing.

OHI/RMOTC Test Daily Report 7/25/04

09:00 AM Leak on the rod packing has seemed to slow a bit when tightened nut up.

10:30 AM Leak detected on main fuel discharge, fixed with pipe wrench.

10:30 AM 6:00 PM Running test without problems.

06:10 PM Shut down test for servicing.

06:30 PM Resume operations RPM 1450/Gal 158

OHI/RMOTC Test Daily Report 7/26/04

07:30 AM Take a Water Sample

07:35 AM Working on clamps to secure casing strings to wellhead. Operation will resume when personnel has finished clamps on casing.

10:45 AM Shut down operations rod oilier dry and pulsation. Damper need charged.

02:30 PM Resume operation. Unable to locate hammer wrench to fit pulsation Damper. Will continue operations until everything is ready to replace Bladder (Power fluid pump).

06:10 PM Test is running with same conditions.

OHI/RMOTC Test Daily Report 7/27/04

07:30 AM Shut down operation to replace damper Bladder and service pump.

12:15 PM Service pump and damper replacement complete. Damper filled to 950 psi with Nitrogen. Restart motor.

12:40 PM Resume Operation. Severe vibration occurred. RPM 1310 / GPM

02:40 PM Idle down to 1500 RPM / 162 GPM.

03:00 PM Shut down operation, bleeds off Damper to 600 psi.

03:18 PM Resume operations 1450 RPM, still experiencing moderate vibration in discharge to well line.

03:50 PM Shut down to bleed off pulsation damper. Vibrations reduced greatly RPM 1450/GPM 156.

04:40 PM Vibration in discharge line getting worse.

04:45 PM Shut Down operations bleed Damper all the way down.

05:00 PM Resume operation, vibration back to normal. RMP 1450/153 GPM/ Pressure 750.

OHI/RMOTC Test Daily Report 7/28/04

7:00 AM Shut down 10 gal in rod oil. Function emergency shut off.

7:12 AM Resume Operation 1450 RPM, !56 GPM.

12:42 PM Small leak in the elbow located at power fluid line. Will fix in the next shut down.

15:50 PM Shut down operation to wire centrifugal pump.

16:50 PM Resume operation, Tightened cap on wellhead string. Leak stopped

OHI/RMOTC Test Daily Report 7/29/04

9:50 AM Spot where leak has been on power fluid line. Now beginning to squirt a little bit.

10:00 AM Pump #2 (Centrifugal) alarm sound and pump shut down to low engine oil indicator will remain shut down for maintenance and servicing.

12:00 PM Resume operations with centrifugal pump. Fixed leak. Notice slight leakage where wellhead comes out of cement pad, will monitor.

12:15 PM Shut down operations severe vibrations on production line.

2:00 PM Resume Operations. Bring up to 1450 RPM only 155 GPM. Shut down to weld bracing on suction feed line.

2.28 PM Resume operation RPM 1450, GPM 156. Bracing has stopped vibration of line. Pressure 1350#.

3.20 PM Start test. Suction feed line dripping on other side of 90 grades. Will be monitor tightening.

OHI/RMOTC Test Daily Report 7/30/04

7:04 AM Begin transferring fluids from production tank to suction tank.

7:20AM Shut down operation for servicing.

7:55 AM Resume Operations for servicing

9:00 AM Shut down to fix leaking flange

9:27 AM Resume operation RPM 1390, 190 GPM, Pressure 1900#

10:00 AM Small leak on 90 grades elbow fluid line.

11:15 AM Adjust backpressure, new pressure 1600#. Closed valve to equalize large Tanks.

11:51 AM Increase RPM to 1686, Pressure 2200#, GPM 225.

16:00 PM Production Discharge line leaking where clamped off above wellhead.

OHI/RMOTC Test Daily Report 7/31/04

7:20 AM RPM 1687 / GPM 230 / Pressure 2100 psi. Production discharge still leaking.

8:00 AM Test shut down for servicing.

8:20 AM Resume Operations. Idle up to RPM 720/ GPM 235/ Pressure 2100. Increased #2 Pump RPM to 1770.

9:58 AM Shut down Operations.

10:32 AM Resume Operations. Replaced clamps holding line to side of tank.

02:00 PM Finding Flow meter sensor for production line discharge. RPM 1685/GPM 242/ Pressure 2100 psi.

2:47 PM Suction from #2 pump to well head brace separated. Shut down due to severe vibration in line.

6:00 PM Resume operation. #1 Pump 1680 RPM/ Pressure 2100 psi/ GPM 246. #2 Pump 1100 RPM.

OHI/RMOTC Test Daily Report 08/01/04

6:00AM Pump down hole appears to be struggling. Possibly suction screens are plugged up.

6:40 AM Shut down for service.

7:45 AM Resume Operations. RPM 1000 psi, surge still present.

8:52 AM Increasing RPM on #2 Pump to try and reduce surge (vibration).

9.20 AM Shut down #2 Pump, pressure regulator is damaged.

9:44 AM Increase RPM to 1430 / GPM 155/ Pressure 750 psi.

1:30 PM RPM to 1430 / GPM 155/ Pressure 800 psi.

5.38 PM Increase RPM 1530 / GPM 170.

OHI/RMOTC Test Daily Report 08/02/04

8:300AM Add 1.5 pallet of calcium chloride to power fluid tank.

9:10 AM Shut down to repair leak at the wellhead.

3:20 PM Resume Operations.

4:26 PM Shut down to bleed off air from production injection line.

4:28 PM Resume operation RPM 1500 / GPM 165/ Pressure 750 psi.

Note:

- Fluid metering gauge (production return line) is out of order. Turbine system is damaged.
- Pump #2 is out of order, control pressure valve is damaged. Production fluid is dropping from gravity, because Pump #2 is out of order, control pressure valve is damaged.

OHI/RMOTC Test Daily Report 08/03/04

6:00AM Performed inspection RPM 1520 / GPM 165/ Pressure 1050 psi.

Slight leak at wellhead on production injection cap. Will tighten at maintenance shut down.

7.13 AM Begin transfer between production tank and power fluid tank. Let it run for approximately 5 hrs (around noon shut off) and take measurements.

9:30 AM Shut down for maintenance. RMOTC personnel provided a flow meter (Halliburton).

9:40 AM Start flow meter installation at return production line.

9:55 AM Resume Operation. RPM 1560 / GPM 170/ Pressure 1050 psi. All leaks fixed.

10:20 AM The operator received information to drop the rate to 4000 BPD; it was a recommendation from Terry Kelly from Texas.

11:30 AM Noticed that pressure gauge on production line didn't drop when pressure was reduced. Pieces of gauges are visible inside. Gauge is damaged.

11.39 AM RMOTC personnel located new gauge and installed.

01.30 PM Performed inspection RPM 1120 / GPM 122/ Pressure 750 psi.

04.30 PM Performed inspection RPM 1120 / GPM 120/ Pressure 750 psi.

Note: The Calcium concentrate at power fluid tank is 1400 mg/L x 1000 Lt

OHI/RMOTC Test Daily Report 08/05/04

9:00AM Work over Rig arrives to rig up and install lubricator on the top of the wellhead. Discussed maintenance and fluid line configuration with Steve Hildebrand.

9:10 AM Discussed rolling tanks with centrifugal pump while we are with all personnel when ready for operations to begin.

10.45 AM Suspend activities for rain and lighting. Safety meeting with RMOTC personnel, OHI and Extreme Petroleum Technology.

11.00 AM Made wellhead and line changes. Pick up lubricator with stinger truck.

1.20 PM Attempt to install flanges between master valve and lubricator. Would not work

1.55 PM First attempt to retrieve pump. Unsuccessful.

2.30 PM Second attempt to retrieve pump. Successful. 2 minutes 21 seconds pump time, 5 barrels pumped.

2.50 PM Lay down lubricator and prepared to ship to OHI - Odessa, Texas.

OHI/RMOTC Test Daily Report 8/12/04

~ 3:30 PM - Called Toby Yates on site to check on well activities. Found that the power fluid tank has not been circulated during the past week and they are not really set up to circulate. The centrifugal pump had been removed from the location and the fluid end was being changed on the Gardner/Denver pump. Changing from 3-1/2" liners to 5". Also with the meters removed was not able to physically pipe the system for circulating.

A potential problem came up during the liner change when the pony rod on one cylinder turned.

OHI/RMOTC Test Daily Report 8/16/04

Pump arrives from Odessa –Texas, Installed lubricator on top of the wellhead with down hole pump inside. Begin re-plumbing some lines and installed turbines meters.

OHI/RMOTC Test Daily Report 8/17/04

- RMOTC personnel have finished plumbing task, set up pump suction line with chemical injection fittings.
- Circulate production tank for approximately 2 hours.

OHI/RMOTC Test Daily Report 8/18/04

- Rain flapper on top of the GD power fluid pump motor was fixed.
- Circulating power fluid tank for 7 hours.
- Added 4 bags of sodium bicarbonate to power fluid tank

OHI/RMOTC Test Daily Report 8/19/04

Activities on site:

-Cleaning Power fluid tank. Changing hose draining connection from 2" to 4", to accelerate the drainage.

-Installing connections with chemical barrel treatment with power fluid line.

Another comment:

-RMOTC personnel will spend Friday and weekend cleaning and filling up the power fluid tank with fresh water come from Ten Sleep Reservoir.

-The test will be suspended until the next Monday 08/23/04.

OHI/RMOTC Test Daily Report 8/20/04

- Spend all day long draining Power fluid tank for inspection and cleaning. Pressure 250 RPM 755.

OHI/RMOTC Test Daily Report 8/21/04

- Start up G.D pumping out power fluid tank, RPM 115, Press 280, 4 Barreles per minute.
- Emptied power fluid tank and filled back to 4 feet with ten sleep water.
- Started pumping out power fluid tank with G.D rims 1190, pressure 300.
- Stop pumping with G.D used Vac truck to pump bottom off fluid tank.
- Hauled last load for the day.

OHI/RMOTC Test Daily Report 8/23/04

- Resume hauling from power fluid tank started rigging back up to fill tank.
- Doing connections to fill up the tank.

- 10.30 AM start procedure to filling up the tank
- 1:30 PM Started procedure to test the Hydraulic Pump but was not enough the height of water to fill up the suction of the power fluid pump.
- Wait for filling up of the tank

OHI/RMOTC Test Daily Report 9/13/04

- Arrangements and safety meeting to develop procedure to set the rig on location to start completion pull up.
- RMOTC personnel finished activities at 5pm. To continue next day.

OHI/RMOTC Test Daily Report 9/14/04

- 8:00 AM Finish rig up of service rig.
- 8:15 AM Pull and lay down 4-1/2" production inlet casing. No indication of problems with the seal assembly.
- 10:00 AM Rig down wellhead and set out.
- 11:35 AM Shut down for lunch.
- 12:35 PM Rig up casing crew and power tongs. Pull 5-1/2" with elevators and support 4-1/2" with sand line.
- 1:00 PM Pull and lay down 5-1/2" power fluid inlet casing and 4-1/2" production return casing. Used power tongs on 5-1/2" and backed out 4-1/2" by hand. No indication of problems with threads or a hole in the casing.
- 2:45 PM Bottom hole assembly hanging in the derrick. Prepared "I" beam to ship bottom hole assembly. Lay down assembly and bolt to "I" beam. The only indication of a problem with the bottom hole assembly was that the guide plate broke off and was left in the well.
- 4:15 PM Start to rig down service rig.

NOTE: There appeared to be oil on top the fluid in the wellbore. The tubulars were apparently coated with corrosion inhibitor as planned. Couple of observations: there needs to be improvements in pressure monitoring with better gauges, placement of the gauges and dampening of the pressure swings; there needs to be better stabilization of the piping to minimize vibration.

Plans for tomorrow are to have arrangements to ship the pump and bottom hole assembly to Texas and winterize the triplex and quintiplex pumps and surface lines and equipment.

Data Sheets

ROC / OHI PDP Testing Data Recording Sheet - Extreme Petroleum Engineering

Date	28-Jul-04
Time	12:50:00 PM

		Flow Meter Readings			
		Power injection	Power return	Production injection	Production return
Totals (bbls)		19,677	19,408	22,512	22,943
Instants (x10bpd)	1	514	495	523	582
	2	511	500	523	585
	3	511	500	523	614
	4	512	503	518	614
	5	509	502	515	613
	6	510	510	513	621
	7	515	510	525	618
	Avg. BPD=>	5,117	5,029	5,200	6,067

Tank Heights (ft)	
Power	Production
4.00	1.80

	Pressure Gauge Readings (psi)			
	Power injection	Power Return	Production injection	Production Return
1	1,150	190	150	720
2	1,200	195	170	730
3	1,150	190	160	720
Avg. PSI=>	1,167	192	160	723

	Stroke Time (s)
1	45.80
2	46.15
3	46.21
Avg. Stroke/Min=>	

Date	28-Jul-04
Time	2:10:00 PM

		Flow Meter Readings			
		Power injection	Power return	Production injection	Production return
Totals (bbls)		19,920	19,649	22,763	23,226
Instants (x10bpd)	1	517	510	519	609
	2	515	510	519	609
	3	515	502	529	541
	4	515	502	528	595
	5	515	504	528	595
	6	516	504	523	593
	7	515	502	516	611
	Avg. BPD=>	5,154	5,049	5,231	5,933

Tank Heights (ft)	
Power	Production
4.00	2.00

	Pressure Gauge Readings (psi)			
	Power injection	Power Return	Production injection	Production Return
1	1,150	190	150	730
2	1,200	195	140	720
3	1,150	190	160	730
Avg. PSI=>	1,167	192	150	727

	Stroke Time (s)
1	45.26
2	45.78
3	45.82
Avg. Stroke/Min=>	

Daily Average Flow Meter Readings (BPD)				Stroke Per min
Power injection	Power return	Production injection	Production return	
5,136	5,039	5,216	6,000	13.09
Daily Avg. Pressure Gauge Readings (PSI)				
Power injection	Power Return	Production injection	Production Return	
1,167	192	155	725	

ROC / OHI PDP Testing Data Recording Sheet - Extreme Petroleum Engineering

Date	29-Jul-04
Time	03:49:00 PM

		Flow Meter Readings			
		Power injection	Power return	Production injection	Production return
Totals (bbls)		65	64	66	81
Instants (x10bpd)	1	520	498	509	572
	2	518	492	501	572
	3	518	492	500	668
	4	518	492	500	616
	5	519	499	503	675
	6	516	499	506	575
	7	516	492	501	542
	Avg. BPD=>	5,179	4,949	5,029	6,029

Tank Heights (ft)	
Power	Production
4.00	1.80

	Pressure Gauge Readings (psi)			
	Power injection	Power Return	Production injection	Production Return
1	1,200	180	120	760
2	1,150	195	120	750
3	1,200	180	120	760
Avg. PSI=>	1,183	185	120	757

	Stroke Time (s)
1	46.50
2	45.70
3	45.80
Avg. Stroke/Min=>	

Date	29-Jul-04
Time	4:35 PM

		Flow Meter Readings			
		Power injection	Power return	Production injection	Production return
Totals (bbls)		228	220	225	269
Instants (x10bpd)	1	518	495	497	583
	2	518	487	504	519
	3	518	491	504	650
	4	517	488	500	650
	5	517	488	496	617
	6	516	496	496	597
	7	518	500	504	513
	Avg. BPD=>	5,174	4,921	5,001	5,899

Tank Heights (ft)	
Power	Production
4.00	1.80

	Pressure Gauge Readings (psi)			
	Power injection	Power Return	Production injection	Production Return
1	1,200	190	110	750
2	1,150	180	115	760
3	1,200	190	115	760
Avg. PSI=>	1,183	187	113	757

	Stroke Time (s)
1	46.25
2	46.30
3	45.85
Avg. Stroke/Min=>	

Daily Average Flow Meter Readings (BPD)				Stroke Per min
Power injection	Power return	Production injection	Production return	
5,176	4,935	5,015	5,964	13.03
Daily Avg. Pressure Gauge Readings (PSI)				
Power injection	Power Return	Production injection	Production Return	

ROC / OHI PDP Testing Data Recording Sheet - Extreme Petroleum Engineering

Date	30-Jul-04
Time	5:35 PM

Fluid metering gauge (production return line) is out of order. Turbine system is damaged.

		Flow Meter Readings			
		Power injection	Power return	Production injection	Production return
Totals (bbls)		1,608	1,613	1,550	13,512
Instants (x10bpd)	1	751	751	701	6,219
	2	751	752	695	6,259
	3	751	752	705	6,420
	4	751	755	686	6,251
	5	751	751	670	6,550
	6	751	751	670	6,292
	7	751	753	679	6,292
	Avg. BPD=>	7,510	7,521	6,866	63,261

Tank Heights (ft)	
Power	Production
2.00	2.40

	Pressure Gauge Readings (psi)			
	Power injection	Power Return	Production injection	Production Return
1	2,250	390	120	1,250
2	2,200	400	130	1,300
3	2,250	390	120	1,250
Avg. PSI=>	2,233	393	123	1,267

	Stroke Time (s)
1	31.37
2	31.09
3	30.59
Avg. Stroke/Min=>	

Date	30-Jul-04
Time	6:58 PM

Fluid metering gauge (production return line) is out of order. Turbine system is damaged.

		Flow Meter Readings			
		Power injection	Power return	Production injection	Production return
Totals (bbls)		2,035	2,040	1,966	17,095
Instants (x10bpd)	1	748	745	701	5,838
	2	751	744	701	5,822
	3	749	744	684	5,865
	4	748	747	681	5,884
	5	748	747	713	5,672
	6	750	745	713	6,008
	7	750	748	755	5,693
	Avg. BPD=>	7,491	7,457	7,069	58,260

Tank Heights (ft)	
Power	Production
2.00	2.40

	Pressure Gauge Readings (psi)			
	Power injection	Power Return	Production injection	Production Return
1	2,250	390	120	1,250
2	2,200	395	120	1,250
3	2,250	390	120	1,250
Avg. PSI=>	2,233	392	120	1,250

	Stroke Time (s)
1	31.77
2	31.28
3	31.54
Avg. Stroke/Min=>	

Daily Average Flow Meter Readings (BPD)				Stroke Per min
Power injection	Power return	Production injection	Production return	
7,501	7,489	6,967	60,761	19.19
Daily Avg. Pressure Gauge Readings (PSI)				
Power injection	Power Return	Production injection	Production Return	
2,233	393	122	1,258	

ROC / OHI PDP Testing Data Recording Sheet - Extreme Petroleum Engineering

Date	31-Jul-04
Time	12:05 PM

Fluid metering gauge (production return line) is out of order. Turbine system is damaged.

		Flow Meter Readings			
		Power injection	Power return	Production injection	Production return
Totals (bbls)		5,479	5,415	5,167	40,855
Instants (x10bpd)	1	800	774	682	4,603
	2	800	774	682	4,899
	3	800	776	673	4,793
	4	799	774	692	4,642
	5	799	772	684	4,969
	6	801	772	684	4,603
	7	800	776	653	4,920
	Avg. BPD=>	7,999	7,740	6,786	47,756

Tank Heights (ft)	
Power	Production
2.00	2.40

	Pressure Gauge Readings (psi)			
	Power injection	Power Return	Production injection	Production Return
1	2,250	370	120	1,100
2	2,300	360	125	1,200
3	2,350	370	125	1,150
Avg. PSI=>	2,300	367	123	1,150

	Stroke Time (s)
1	31.58
2	31.43
3	30.55
Avg. Stroke/Min=>	

Date	31-Jul-04
Time	1:05 PM

Fluid metering gauge (production return line) is out of order. Turbine system is damaged.

		Flow Meter Readings			
		Power injection	Power return	Production injection	Production return
Totals (bbls)		5,758	5,686	5,418	52,550
Instants (x10bpd)	1	798	780	774	4,900
	2	797	778	764	4,554
	3	797	728	783	4,910
	4	799	728	779	4,851
	5	798	780	778	4,748
	7	798	779	778	5,066
	8	797	780	773	4,821
	Avg. BPD=>	7,977	7,647	7,756	48,357

Tank Heights (ft)	
Power	Production
2.00	2.40

	Pressure Gauge Readings (psi)			
	Power injection	Power Return	Production injection	Production Return
1	2,300	370	130	1,150
2	2,350	375	135	1,150
3	2,300	375	130	1,200
Avg. PSI=>	2,317	373	132	1,167

	Stroke Time (s)
1	31.05
2	30.50
3	30.84
Avg. Stroke/Min=>	

Daily Average Flow Meter Readings (BPD)				Stroke Per min
Power injection	Power return	Production injection	Production return	
7,988	7,694	7,271	48,056	19.36
Daily Avg. Pressure Gauge Readings (PSI)				
Power injection	Power Return	Production injection	Production Return	
2,308	370	128	1,158	

ROC / OHI PDP Testing Data Recording Sheet - Extreme Petroleum Engineering

Date	1-Aug-04
Time	12:10 PM

Fluid metering gauge (production return line) is out of order. Turbine system is damaged.

		Flow Meter Readings			
		Power injection	Power return	Production injection	Production return
Totals (bbls)		11,479	11,284	10,833	49,807
Instants (x10bpd)	1	530	493	266	154
	2	514	503	316	87
	3	510	492	377	100
	4	527	468	308	150
	5	529	493	262	165
	6	517	495	304	94
	7	510	489	327	81
	Avg. BPD=>	5,196	4,904	3,086	1,187

Tank Heights (ft)	
Power	Production
2.00	2.40

	Pressure Gauge Readings (psi)			
	Power injection	Power Return	Production injection	Production Return
1	1,200	180	0	650
2	1,250	180	0	700
3	1,250	185	0	700
Avg. PSI=>	1,233	182	0	683

	Stroke Time (s)
1	46.15
2	47.20
3	46.80
Avg. Stroke/Min=>	

Date	1-Aug-04
Time	1:10 PM

Fluid metering gauge (production return line) is out of order. Turbine system is damaged.

		Flow Meter Readings			
		Power injection	Power return	Production injection	Production return
Totals (bbls)		11,722	11,513	10,981	49,874
Instants (x10bpd)	1	513	492	273	149
	2	522	499	383	147
	3	537	496	359	92
	4	518	475	263	84
	5	511	487	256	145
	6	519	500	382	170
	7	529	496	374	90
	Avg. BPD=>	5,213	4,921	3,271	1,253

Tank Heights (ft)	
Power	Production
2.00	2.40

	Pressure Gauge Readings (psi)			
	Power injection	Power Return	Production injection	Production Return
1	1,300	180	0	600
2	1,200	190	0	650
3	1,275	180	0	600
Avg. PSI=>	1,258	183	0	617

	Stroke Time (s)
1	46.40
2	47.05
3	46.85
Avg. Stroke/Min=>	

Daily Average Flow Meter Readings (BPD)				Stroke Per min
Power injection	Power return	Production injection	Production return	
5,204	4,913	3,179	1,220	12.84
Daily Avg. Pressure Gauge Readings (PSI)				
Power injection	Power Return	Production injection	Production Return	
1,246	183	0	650	

ROC / OHI PDP Testing Data Recording Sheet - Extreme Petroleum Engineering

Date	2-Aug-04
Time	3:38 PM

Fluid metering gauge (production return line) is out of order. Turbine system is damaged.

		Flow Meter Readings			
		Power injection	Power return	Production injection	Production return
Totals (bbls)		16,191	15,744	13,733	31,431
Instants (x10bpd)	1	546	512	306	97
	2	548	514	427	117
	3	548	516	416	171
	4	541	516	420	171
	5	539	519	418	63
	7	539	517	405	75
	8	544	517	405	119
	Avg. BPD=>	5,436	5,159	3,996	1,161

Tank Heights (ft)	
Power	Production
5.40	1.70

	Pressure Gauge Readings (psi)			
	Power injection	Power Return	Production injection	Production Return
1	800	180	0	500
2	850	175	0	500
3	800	180	0	500
Avg. PSI=>	817	178	0	500

Time of 10 cicles stroke

	Stroke Time (s)
1	44.45
2	44.58
3	44.60
Avg. Stroke/Min=>	

Date	2-Aug-04
Time	4:26 PM

Fluid metering gauge (production return line) is out of order. Turbine system is damaged.

		Flow Meter Readings			
		Power injection	Power return	Production injection	Production return
Totals (bbls)		16,365	15,908	13,845	0
Instants (x10bpd)	1	540	516	307	0
	2	551	523	405	0
	3	552	523	314	0
	4	552	516	405	0
	5	551	512	394	0
	6	548	512	333	0
	7	544	525	305	0
	Avg. BPD=>	5,483	5,181	3,519	0

Tank Heights (ft)	
Power	Production
5.40	1.70

	Pressure Gauge Readings (psi)			
	Power injection	Power Return	Production injection	Production Return
1	900	180	0	750
2	850	175	0	700
3	850	190	0	750
Avg. PSI=>	867	182	0	733

	Stroke Time (s)
1	44.23
2	43.58
3	45.15
Avg. Stroke/Min=>	

Daily Average Flow Meter Readings (BPD)				Stroke Per min
Power injection	Power return	Production injection	Production return	
5,459	5,170	3,757	581	13.51
Daily Avg. Pressure Gauge Readings (PSI)				
Power injection	Power Return	Production injection	Production Return	
842	180	0	617	

ROC / OHI PDP Testing Data Recording Sheet - Extreme Petroleum Engineering

Date	3-Aug-04
Time	3:19 PM

New flow meter Halliburton - (Installed by 08/03/04)

		Flow Meter Readings			
		Power injection	Power return	Production injection	Production return
Totals (bbls)		21,077	20,346	16,757	558
Instants (x10bpd)	1	403	384	230	300
	2	404	371	256	360
	3	404	374	329	364
	4	313	378	329	360
	5	410	357	295	360
	6	401	357	295	360
	7	405	392	295	364
	Avg. BPD=>	3,914	3,733	2,899	3,526

Tank Heights (ft)	
Power	Production
4.00	2.80

	Pressure Gauge Readings (psi)			
	Power injection	Power Return	Production injection	Production Return
1	750	110	0	500
2	800	100	0	500
3	750	100	0	500
Avg. PSI=>	767	103	0	500

Time of 10 cicles stroke

	Stroke Time (s)
1	65.85
2	65.60
3	65.98
Avg. Stroke/Min=>	

Date	3-Aug-04
Time	4:19 AM

New flow meter Halliburton - (Installed by 08/03/04)

		Flow Meter Readings			
		Power injection	Power return	Production injection	Production return
Totals (bbls)		21,238	20,497	16,849	656
Instants (x10bpd)	1	388	392	313	364
	2	406	354	317	360
	3	394	385	318	368
	4	399	365	311	364
	5	403	370	318	368
	6	403	370	313	364
	7	392	380	319	368
	Avg. BPD=>	3,979	3,737	3,156	3,651

Tank Heights (ft)	
Power	Production
4.00	2.80

	Pressure Gauge Readings (psi)			
	Power injection	Power Return	Production injection	Production Return
1	750	110	0	500
2	800	100	0	500
3	750	100	0	500
Avg. PSI=>	767	103	0	500

Time of 10 cicles stroke

	Stroke Time (s)
1	65.58
2	65.55
3	65.63
Avg. Stroke/Min=>	

Daily Average Flow Meter Readings (BPD)				Stroke Per min
Power injection	Power return	Production injection	Production return	
3,946	3,735	3,027	3,589	9.13
Daily Avg. Pressure Gauge Readings (PSI)				
Power injection	Power Return	Production injection	Production Return	
767	103	0	500	

ROC / OHI PDP Testing Data Recording Sheet - Extreme Petroleum Engineering

Date	4-Aug-04
Time	8:20 AM

New flow meter Halliburton - (Installed by 08/03/04)

		Flow Meter Readings			
		Power injection	Power return	Production injection	Production return
Totals (bbls)		23,872	22,959	18,340	
Instants (x10bpd)	1	387	365	335	334
	2	407	375	327	368
	3	390	353	312	353
	4	391	356	225	368
	5	401	375	262	357
	7	391	354	327	357
	8	401	375	327	368
	Avg. BPD=>	3,954	3,647	3,021	3,579

Tank Heights (ft)	
Power	Production
4.00	2.80

	Pressure Gauge Readings (psi)			
	Power injection	Power Return	Production injection	Production Return
1	800	85	0	525
2	800	85	0	525
3	800	85	0	525
Avg. PSI=>	800	85	0	525

Time of 10 cicles stroke

	Stroke Time (s)
1	66.11
2	66.03
3	66.12
Avg. Stroke/Min=>	

Date	4-Aug-04
Time	9:31 AM

New flow meter Halliburton - (Installed by 08/03/04)

		Flow Meter Readings			
		Power injection	Power return	Production injection	Production return
Totals (bbls)		24,014	23,094	18,340	
Instants (x10bpd)	1	385	359	335	357
	2	385	389	327	368
	3	403	365	312	364
	4	400	371	327	342
	5	391	381	312	353
	7	395	371	320	342
	8	401	381	335	368
	Avg. BPD=>	3,943	3,739	3,240	3,563

Tank Heights (ft)	
Power	Production
4.00	2.80

	Pressure Gauge Readings (psi)			
	Power injection	Power Return	Production injection	Production Return
1	800	80	0	450
2	800	80	0	450
3	800	80	0	450
Avg. PSI=>	800	80	0	450

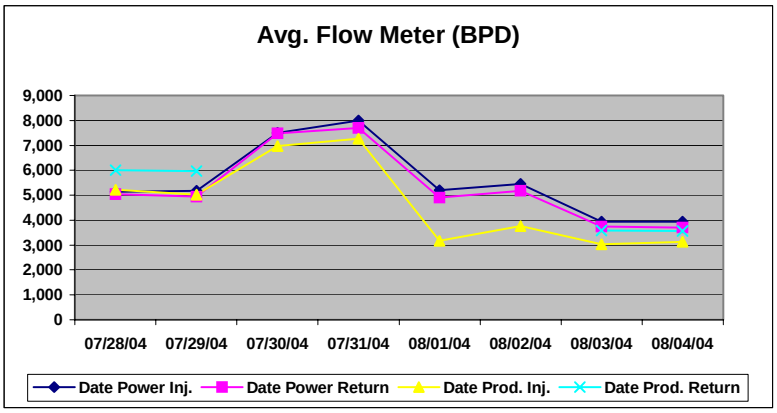
Time of 10 cicles stroke

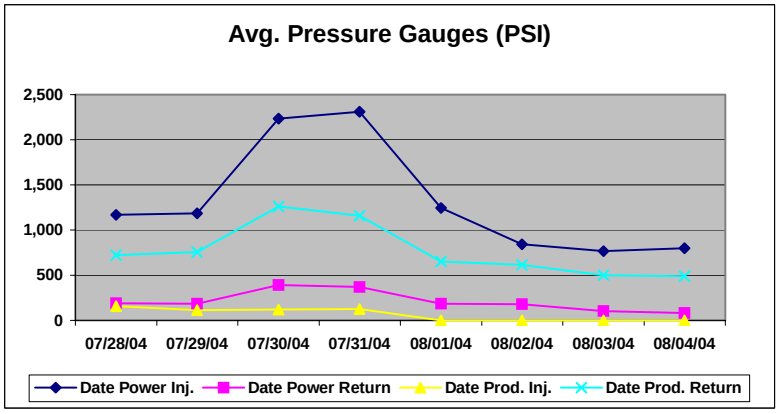
	Stroke Time (s)
1	63.36
2	63.43
3	63.32
Avg. Stroke/Min=>	

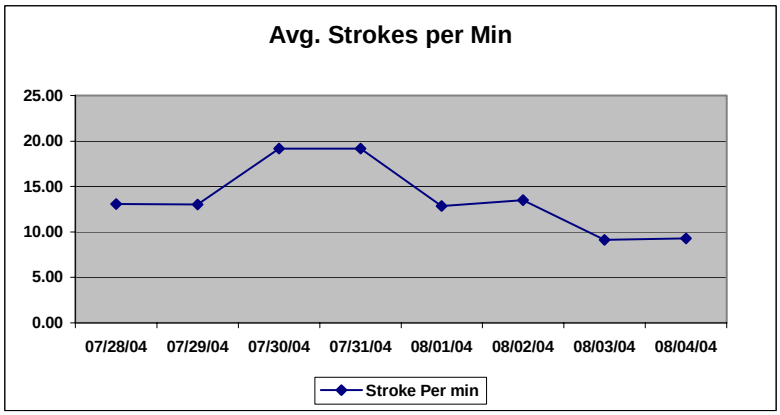
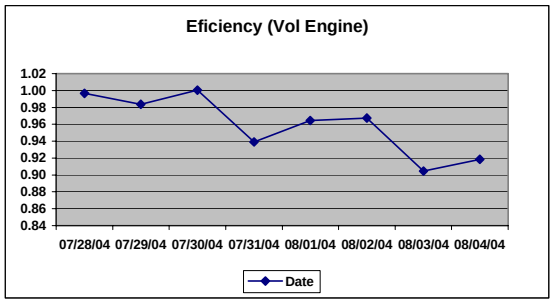
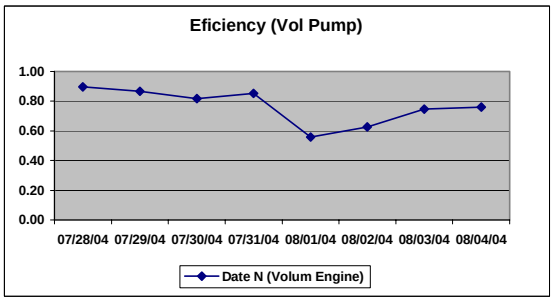
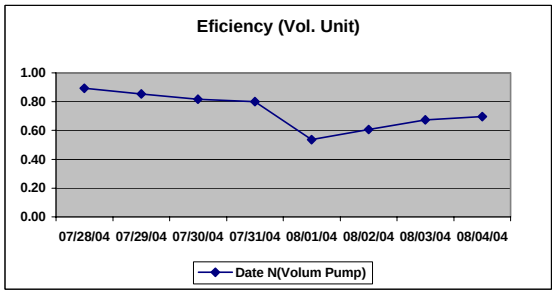
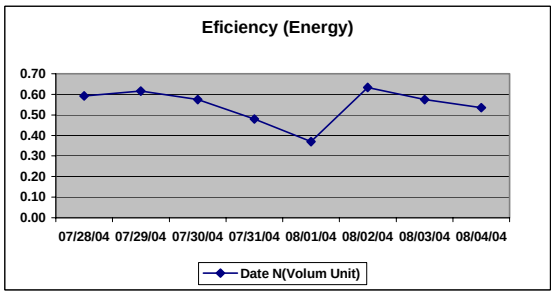
Daily Average Flow Meter Readings (BPD)				Stroke Per min
Power injection	Power return	Production injection	Production return	
3,949	3,693	3,131	3,571	9.27
Daily Avg. Pressure Gauge Readings (PSI)				
Power injection	Power Return	Production injection	Production Return	
800	83	0	488	

ROC / OHI PDP Testing Data Recording Sheet - Extreme Petroleum Engineering

Date	Daily Average Flow Meter Readings (BPD)				Daily Avg. Pressure Gauge Readings (PSI)				Stroke Per min
	Power Inj.	Power Return	Prod. Inj.	Prod. Return	Power Inj.	Power Return	Prod. Inj.	Prod. Return	
07/28/04	5,136	5,039	5,216	6,000	1,167	192	155	725	13.09
07/29/04	5,176	4,935	5,015	5,964	1,183	186	117	757	13.03
07/30/04	7,501	7,489	6,967		2,233	393	122	1,258	19.19
07/31/04	7,988	7,694	7,271		2,308	370	128	1,158	19.19
08/01/04	5,204	4,913	3,179		1,246	183	0	650	12.84
08/02/04	5,459	5,170	3,757		842	180	0	617	13.51
08/03/04	3,946	3,735	3,027	3,589	767	103	0	500	9.13
08/04/04	3,949	3,693	3,131	3,571	800	83	0	488	9.27







Date	Eficiency			
	N (Volum Engine)	N(Volum Pump)	N(Volum Unit)	N(Energy)
07/28/04	1.00	0.90	0.89	0.59
07/29/04	0.98	0.87	0.85	0.62
07/30/04	1.00	0.82	0.82	0.57
07/31/04	0.94	0.85	0.80	0.48
08/01/04	0.96	0.56	0.54	0.37
08/02/04	0.97	0.63	0.61	0.63
08/03/04	0.90	0.75	0.68	0.57
08/04/04	0.92	0.76	0.70	0.53
Average =>	**0.96**	**0.77**	**0.74**	**0.55**