Alberta Department of Energy

Innovative Energy Technologies Program

BRINTNELL FIELD HORSETAIL POLYMER FLOOD PILOT PROJECT

Canadian Natural Resources Limited

Annual Report

June 30th, 2006

Alberta
ENERGY

Summary

Canadian Natural Resources Limited has had a successful year operating the Brintnell polymer flood pilot. The year has brought several challenges and has presented a wealth of data that is currently being analyzed and incorporated into future plans.

The subject project is a pilot designed to evaluate the feasibility, both technical and economic, of polymer flooding in the Wabiskaw zone of the Brintnell Field within the Pelican Lake area. To this end CNRL has gained significant operating experience and technical data to aid in evaluating the success of the project.

Currently there are two polymer injectors with three offset producers comprising the pilot pad. The two injectors have been injecting at a steady rate since they were commissioned and two of the three producers have shown response to the higher pressure being developed in the reservoir. The specifics of the results will be discussed throughout this report, but suffice it to say that there is encouraging response. The reservoir is responding to the polymer injection and thus far positive production response has been recorded and continues to develop.

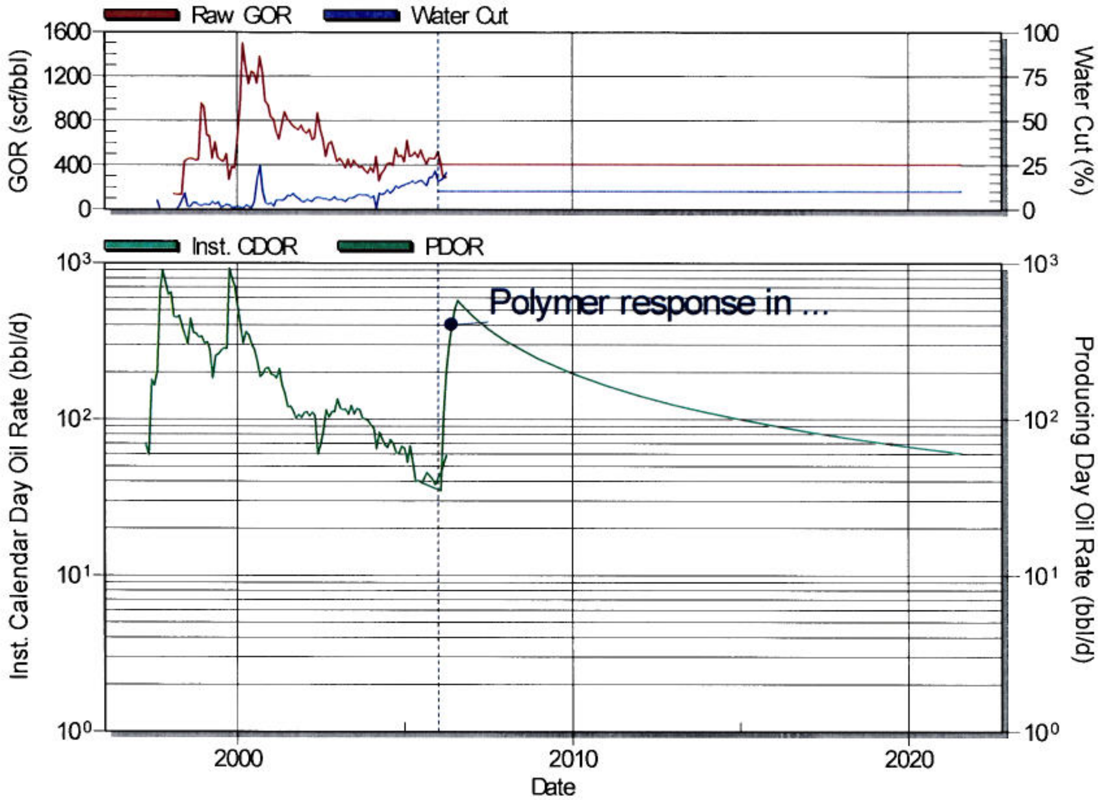
Chronological Report of Activities

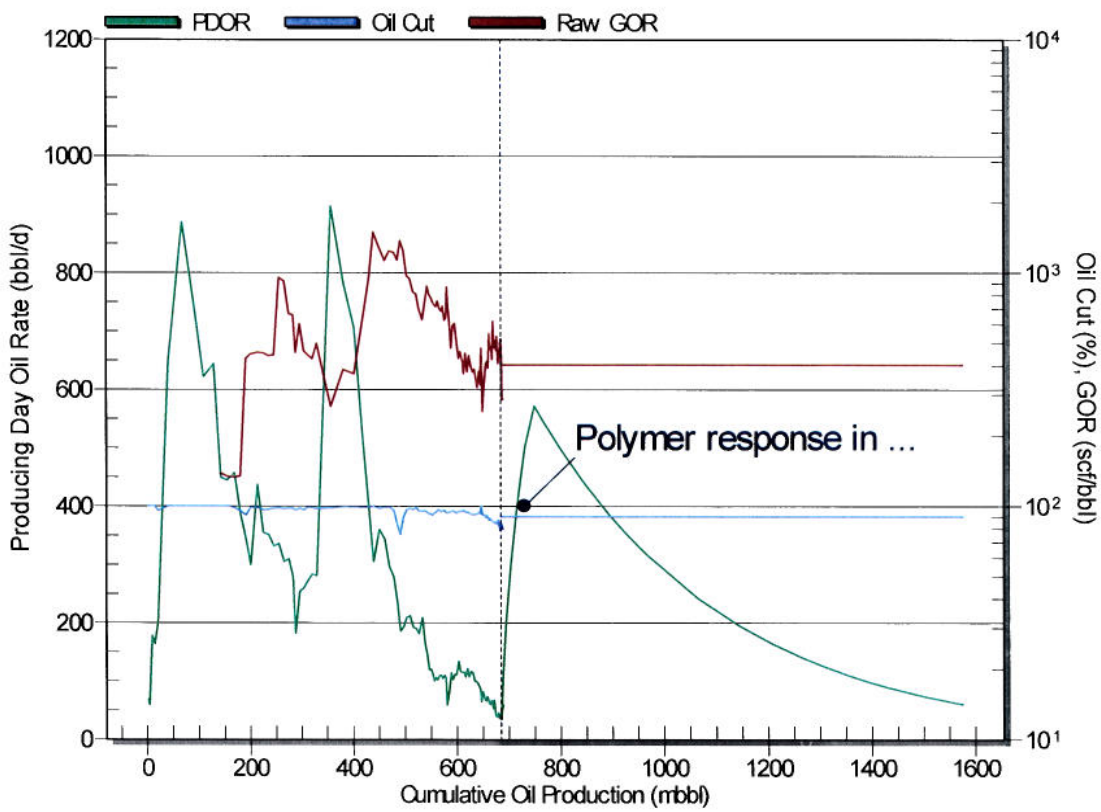
Since the commencement of polymer injection in May 2005 several operational changes have been made. The following is a listing of the date, operation, and impetus for each of the actions taken:

Date	Operation	Impetus
Late August 2005	Viscosity of Injected Polymer Reduced. Reduced from ~20cp to ~13cp.	Following original plan polymer concentration (i.e. viscosity) was reduced once a predetermined pressure response at wellhead was observed.
Sept 22nd 2005	Received increase to Maximum Allowable Wellhead Injection Pressure (MAWIP) to 7650kPa	Applied for approval in anticipation of exceeding existing MAWIP of 3500kPa.
November 24th 2005	Switched from higher molecular weight polymer to lower molecular weight polymer.	Pressure at injectors was rising faster than anticipated. Hypothesis was that there may be plugging of pore throats due to high molecular weight (and hence molecule size) of polymer. The switch to lower molecular weight polymer (12 Daltons vs. 20 Daltons) was an attempt to ensure skin damage was not a driving factor in developing pressure at the injection wellhead. Decreasing molecular weight necessitated an increased concentration of polymer to maintain viscosity.
April 20th 2006	Pump Change at 00/15-34-081-22W4M.	Increasing fluid levels at this producer necessitated a larger downhole pump to move the fluid efficiently i.e. Production Response.
June 4th 2006	Pump Change at 00/14-34-081-22W4M.	Increasing fluid levels at this producer necessitated a larger downhole pump to move the fluid efficiently i.e. Production Response

Updated Incremental Reserves and Production

Given recent production response, reserves and production estimates have been revised upwards compared to the original numbers presented.





The revision represents an increase of 11% on the previously estimated EUR. This reserve booking has been verified by our third party reserves evaluator (Sproule and Associates).

Wabiskaw Reservoir Characterization – Horsetail Polymer Flood Pilot

The Wabiskaw member is the basal unit of the lower Cretaceous Clearwater Formation and is informally subdivided into three sands encountered downhole as the "A" sand, "B" sand, and "C" sand respectively. The three sands of the Wabiskaw represent a prograding shoreface-attached bar complex overlying the fluvial to restricted bay sediments of the McMurray Formation, and capped by the transgressive marine shale of the Clearwater Formation. The three coarsening-upward Wabiskaw sands are separated by shale and range in thickness, saturation, and permeability with the "A" sand being the thickest and most prolific reservoir in the Brintnell area. The "A" sand is a continuous and homogenous northeast-southwest trending body that ranges from 4-7 meters in the CNR Brintnell area with an average thickness of 5 meters.

Internally the "A" sand can be further divided into three locally mappable facies based on sedimentary and electric-log character as shown in the table below:

Geological Properties by Facies

	Facies 1	Facies 2	Facies 3
Thickness	0.1m	2.0 m	2.0 m
Porosity	25	31	27
Kh	878	2900	1500
Kv	*598	*1600	*750
Oil Sat.	41	65	55
Water Sat.	59	35	45

Core: 00/06-11-082-22W4

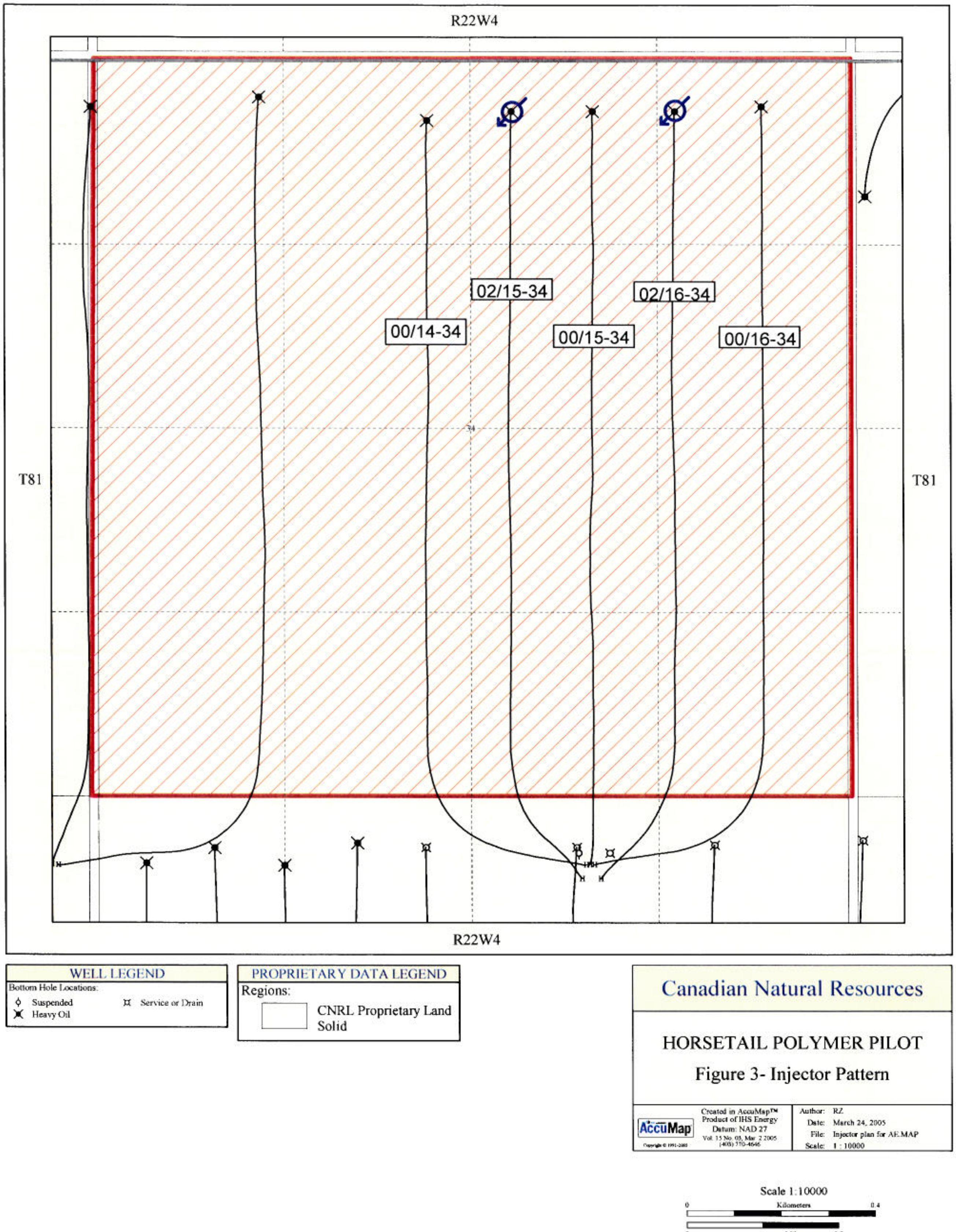
*Inferred from Kh/Kv ratios in nearby wells.

Facies 1 comprises the uppermost sediments in each well with an average thickness in the application area of 30 cm. Facies 2 is the main reservoir body, harboring the highest oil saturation, porosity, and permeability, with an average thickness of 2.5 meters in the application area. Facies 3 comprises the lower sediments of the Wabiskaw "A" sand at Brintnell with an average thickness of 2 meters and displays slightly lower saturation and permeability due to increased laminated and dispersed mud.

All three facies share a similar composition including a predominance of quartz grains and chert that appear subrounded to subangular and well-sorted. Glauconite is present in the Wabiskaw as well as fines consisting of Illite, Chlorite, Kaolinite, and Smectite. Facies 2 contains the most effectively sorted and coarsest sediment with an upper fine-grained sand. The matrix is unconsolidated sand with disseminated fines decreasing upwards through Facies 3 and Facies 2 before reappearing and decreasing pore space in Facies 1.

Structure in the pool dips slightly to the southwest with no bottom water present in the Brintnell area north of Township 78. Gas is present in small isolated pockets based on electric-log mapping. There are no known gas caps within the proposed injection patterns.

Well Layout



The wells shown above are offset 175m in the East-West direction and are approximately 1375m in lateral length. Patterns are inferred to be centered on each injector with the centre well (00/15-34) contributing 50% of it's production to each injector and the two outside producers allocated 100% to the nearest offset injector.

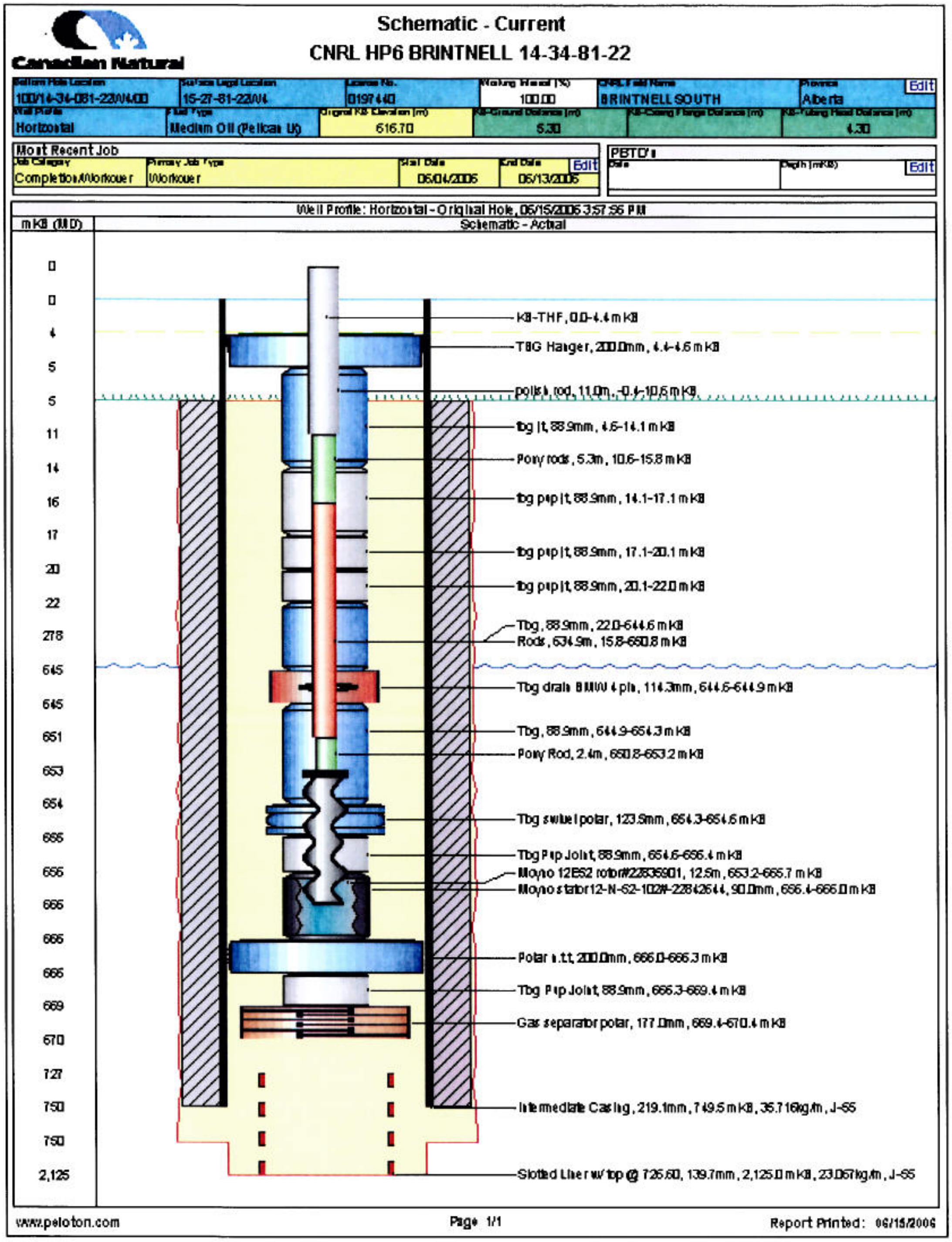
Well List and Details

UWI	Licence #	Well Name	TV Depth	R/R Date	Status
00/16-34-081-22W4/0	197442	CNRES HZ BRINTNELL 16-34-81-22	412.3	03/12/1997	Producer
02/16-34-081-22W4/0	223817	CNRES HZ BRINTNELL 16-34-81-22	409.9	08/03/1999	Poly Injector
00/15-34-081-22W4/0	197441	CNRES HZ BRINTNELL 15-34-81-22	412.2	03/02/1997	Producer
02/15-34-081-22W4/0	223816	CNRES HZ BRINTNELL 15-34-81-22	409.6	08/09/1999	Poly Injector
00/14-34-081-22W4/0	197440	CNRES HZ BRINTNELL 14-34-81-22	411.9	02/22/1997	Producer

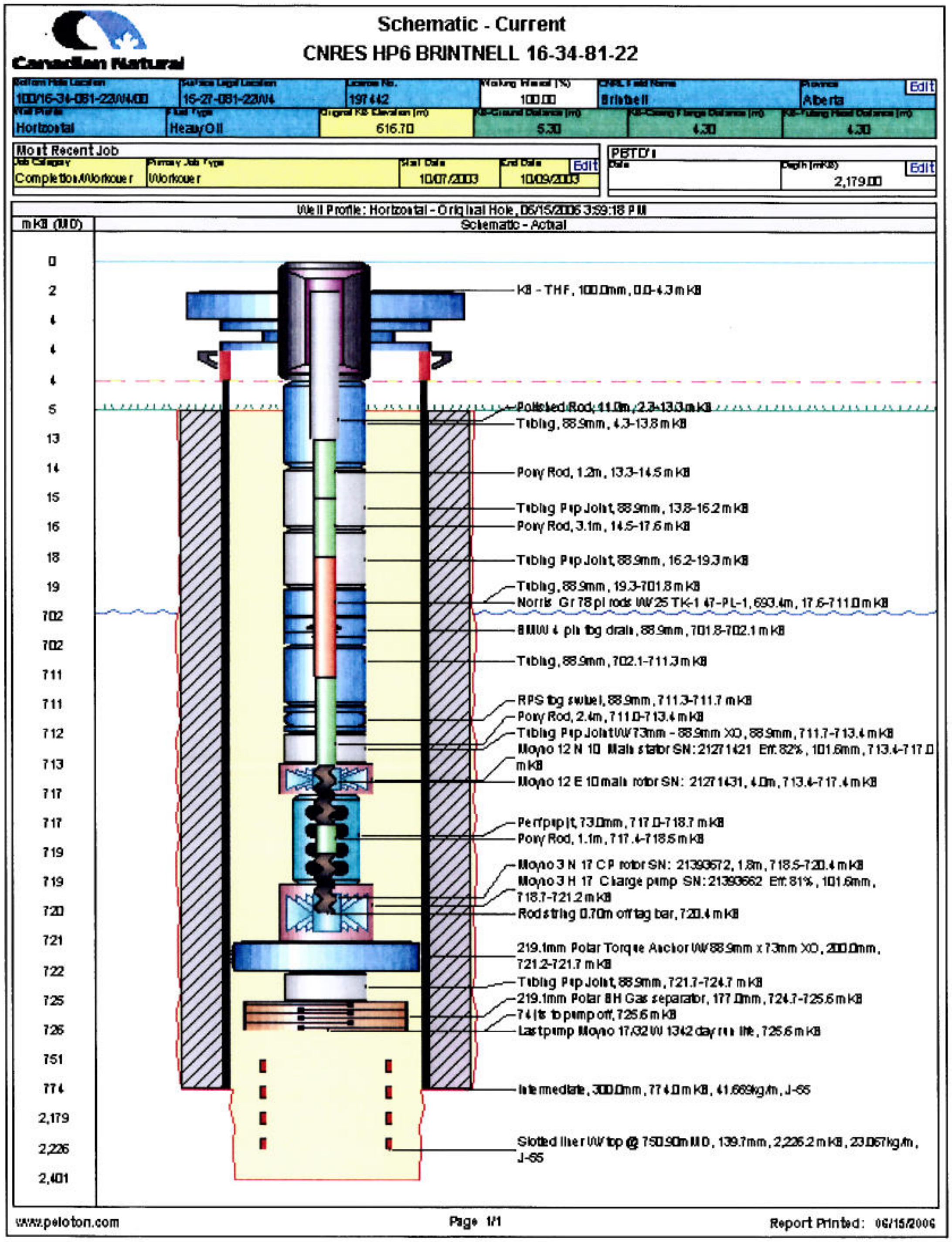
The following pages contain the wellbore schematics for the above wells involved in the polymer pilot.

Wellbore Schematics

Producers:



Injectors:



Schematic - Current
CNRES HP6 BRINTNELL 16-34-81-22
Canadian Natural
100/16-34-081-22W4/00
15-27-081-22W4
197442
100.00
Brintnell
Alberta
Edit
Horizontal
Heavy Oil
616.70
5.30
4.30
4.30
Most Recent Job
Completion/Workover
Workover
10/07/2003
10/09/2003
Edit
PBTD's
2,179.00
Edit
Well Profile: Horizontal - Original Hole, 06/15/2006 3:59:18 PM
mKB (MD)
Schematic - Actual
0
2
4
4
4
5
13
14
15
16
18
19
702
702
711
711
712
713
717
717
719
719
720
721
722
725
726
751
774
2,179
2,226
2,401
KB - THF, 100.0mm, 0.0-4.3 m KB
Polished Rod, 11.0m, 2.3-13.3 m KB
Tubing, 88.9mm, 4.3-13.8 m KB
Pony Rod, 1.2m, 13.3-14.5 m KB
Tubing Pup Joint, 88.9mm, 13.8-16.2 m KB
Pony Rod, 3.1m, 14.5-17.6 m KB
Tubing Pup Joint, 88.9mm, 16.2-19.3 m KB
Tubing, 88.9mm, 19.3-701.8 m KB
Norris Gr 78 pl rods W/25 TK-1 47-PL-1, 693.4m, 17.6-711.0 m KB
BMW 4 pin tbg drain, 88.9mm, 701.8-702.1 m KB
Tubing, 88.9mm, 702.1-711.3 m KB
RPS tbg swivel, 88.9mm, 711.3-711.7 m KB
Pony Rod, 2.4m, 711.0-713.4 m KB
Tubing Pup Joint W/73mm - 88.9mm XO, 88.9mm, 711.7-713.4 m KB
Moyno 12 N 10 Main stator SN: 21271421 Eff: 82%, 101.6mm, 713.4-717.0 m KB
Moyno 12 E 10 main rotor SN: 21271431, 4.0m, 713.4-717.4 m KB
Perf pup jt, 73.0mm, 717.0-718.7 m KB
Pony Rod, 1.1m, 717.4-718.5 m KB
Moyno 3 N 17 CP rotor SN: 21393672, 1.8m, 718.5-720.4 m KB
Moyno 3 H 17 Charge pump SN: 21393662 Eff: 81%, 101.6mm, 718.7-721.2 m KB
Rod string 0.70m off tag bar, 720.4 m KB
219.1mm Polar Torque Anchor W/88.9mm x 73mm XO, 200.0mm, 721.2-721.7 m KB
Tubing Pup Joint, 88.9mm, 721.7-724.7 m KB
219.1mm Polar BH Gas separator, 177.0mm, 724.7-725.6 m KB
74 jts to pump off, 725.6 m KB
Last pump Moyno 17/32 W 1342 day run life, 725.6 m KB
Intermediate, 300.0mm, 774.0 m KB, 41.669kg/m, J-55
Slotted liner W/ top @ 750.90m MD, 139.7mm, 2,226.2 m KB, 23.067kg/m, J-55
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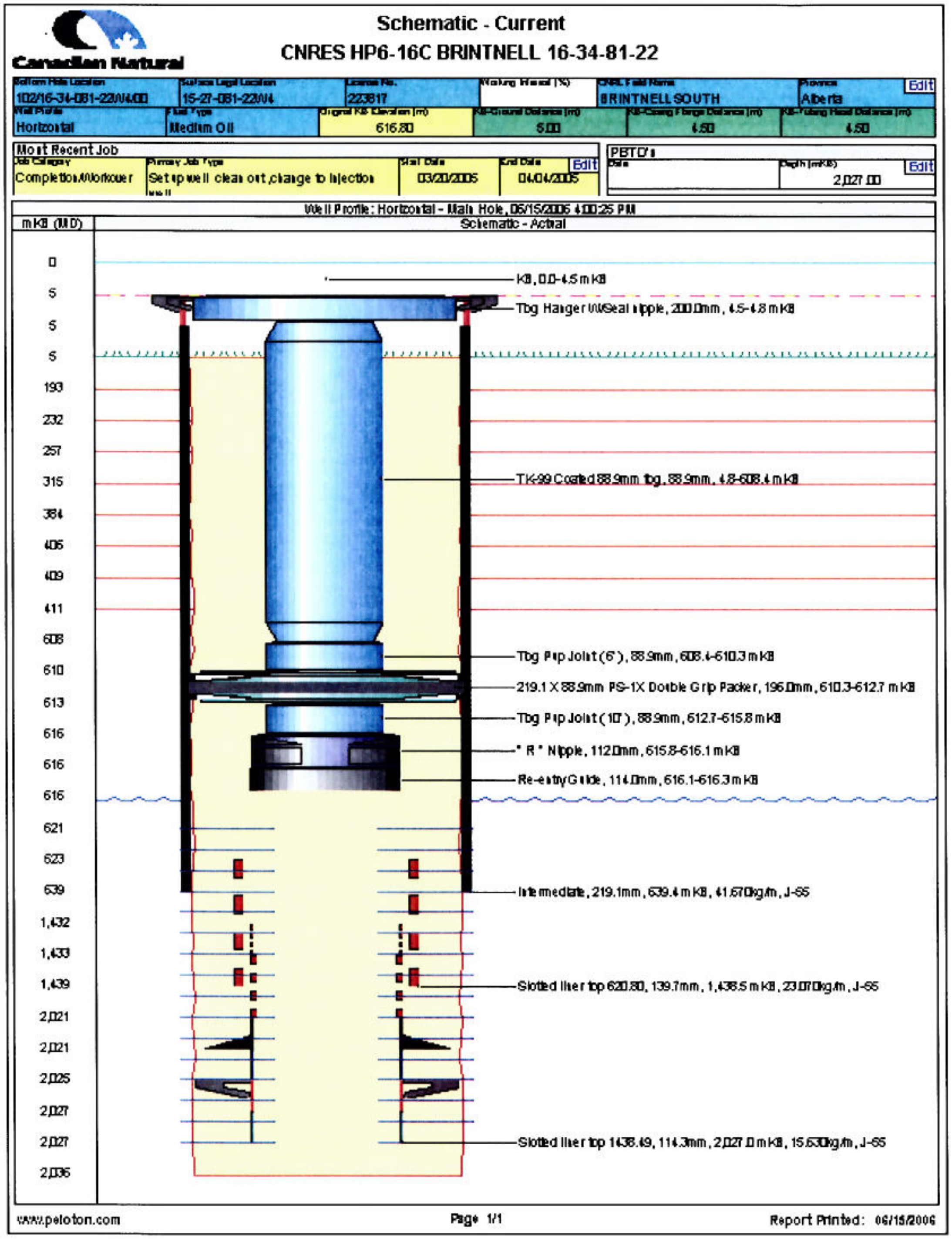
Canadian Natural
Schematic - Current
CNRES HP6-16C BRINTNELL 16-34-81-22
Bottom Hole Location
102/16-34-081-22W4/00
Surface Legal Location
15-27-081-22W4
License No.
223817
Working Interest (%)
CNRL Field Name
BRINTNELL SOUTH
Province
Alberta
Edit
Well Profile
Horizontal
Fluid Type
Medium Oil
Original KB Elevation (m)
616.80
KB-Ground Distance (m)
5.00
KB-Casing Flange Distance (m)
4.50
KB-Tubing Head Distance (m)
4.50
Most Recent Job
Job Category
Completion/Workover
Primary Job Type
Set up well clean out,change to injection well
Start Date
03/20/2005
End Date
04/04/2005
Edit
PBTD's
Date
Depth (mKB)
2,027.00
Edit
Well Profile: Horizontal - Main Hole, 06/15/2006 4:00:25 PM
mKB (MD)
Schematic - Actual
KB, 0.0-4.5 mKB
Tbg Hanger W/Seal nipple, 200.0mm, 4.5-4.8 mKB
TK-99 Coated 88.9mm tbg, 88.9mm, 4.8-608.4 mKB
Tbg Pup Joint (6'), 88.9mm, 608.4-610.3 mKB
219.1 X 88.9mm PS-1X Double Grip Packer, 196.0mm, 610.3-612.7 mKB
Tbg Pup Joint (10'), 88.9mm, 612.7-615.8 mKB
" R " Nipple, 112.0mm, 615.8-616.1 mKB
Re-entry Guide, 114.0mm, 616.1-616.3 mKB
Intermediate, 219.1mm, 639.4 mKB, 41.670kg/m, J-55
Slotted liner top 620.80, 139.7mm, 1,438.5 mKB, 23.070kg/m, J-55
Slotted liner top 1438.49, 114.3mm, 2,027.0 mKB, 15.630kg/m, J-55
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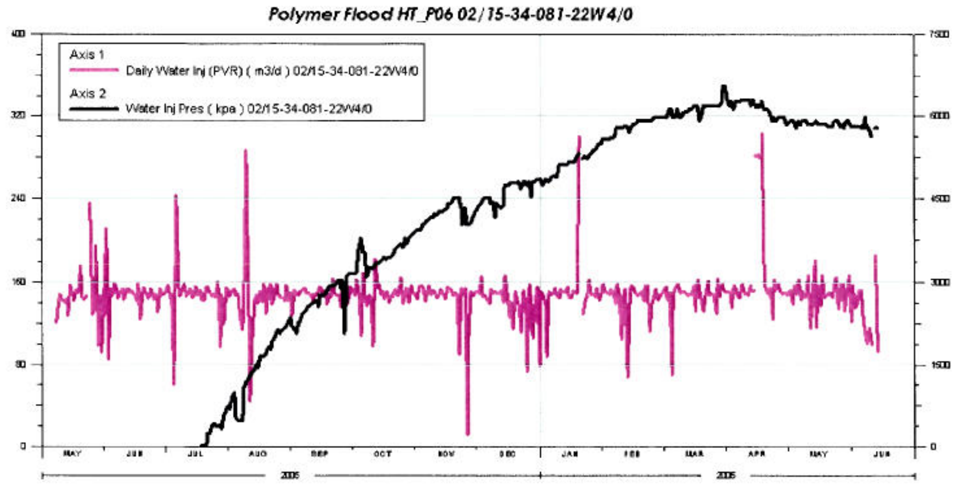
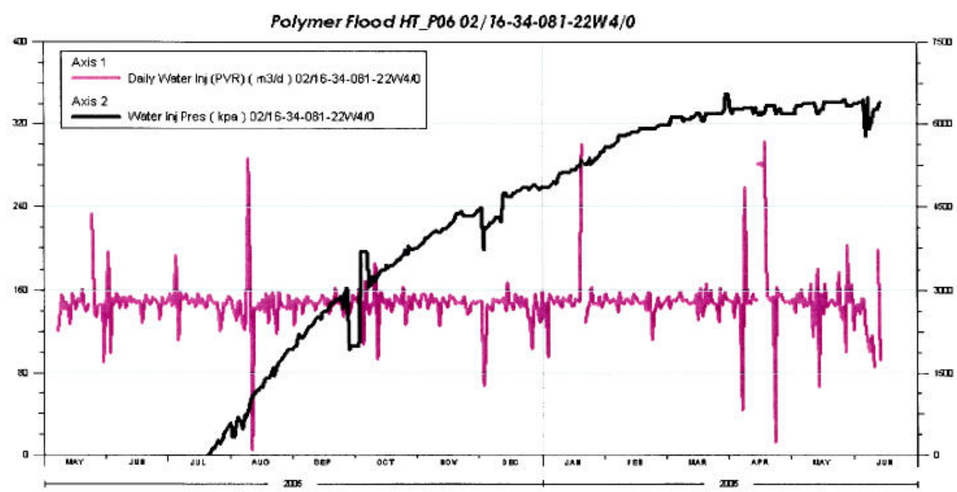
Production / Injection Performance and Data

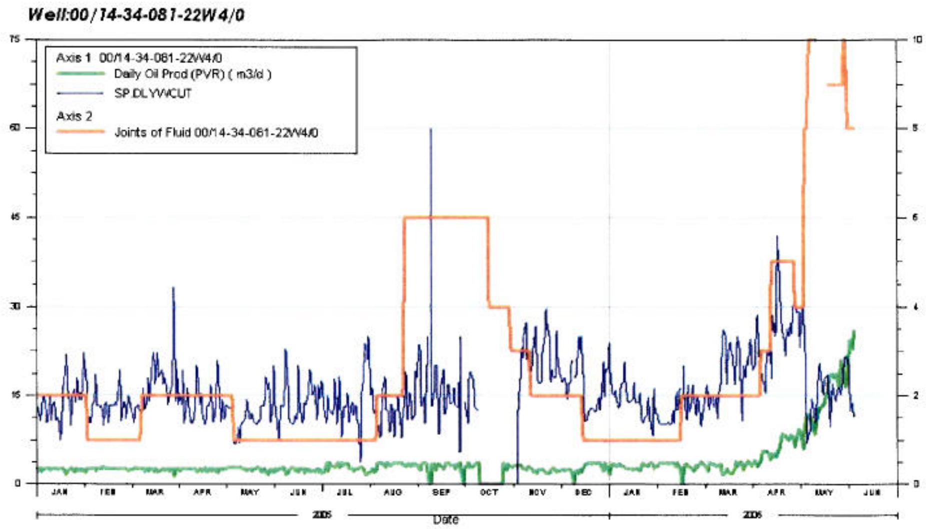
Below are individual and group plots for the wells included in the polymer pilot. Injection volumes and pressures are plotted against time with production volumes and cuts done on the same scale.



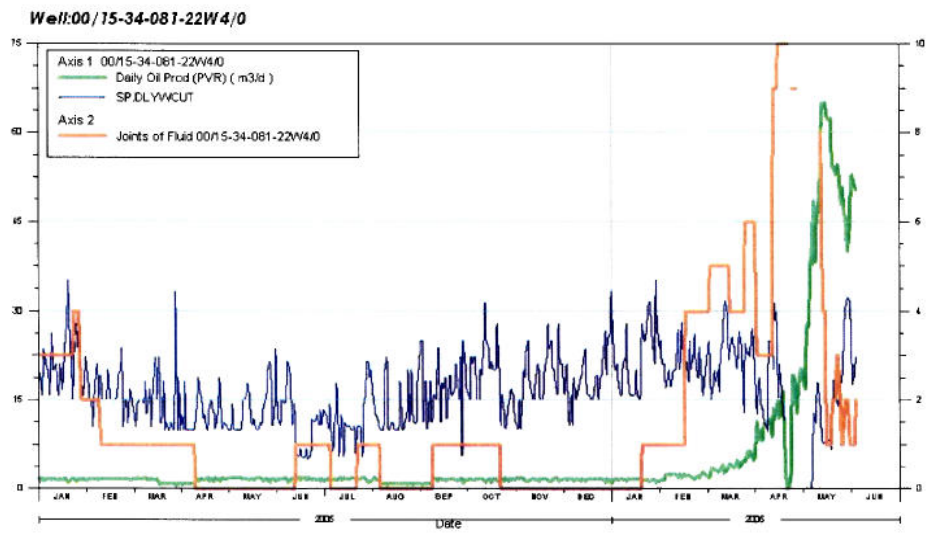
The 15-34 polymer injector has behaved as expected. As the pattern is approaching fillup the pressure has begun to level off as the production response develops.



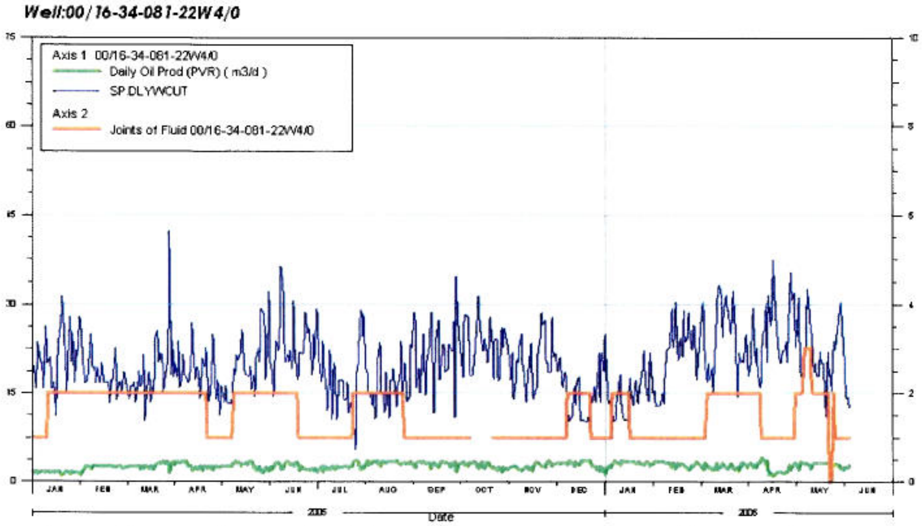
The 16-34 polymer injector has performed much as the 15-35 injector and as the pattern approaches fillup the pressure has begun to level off.



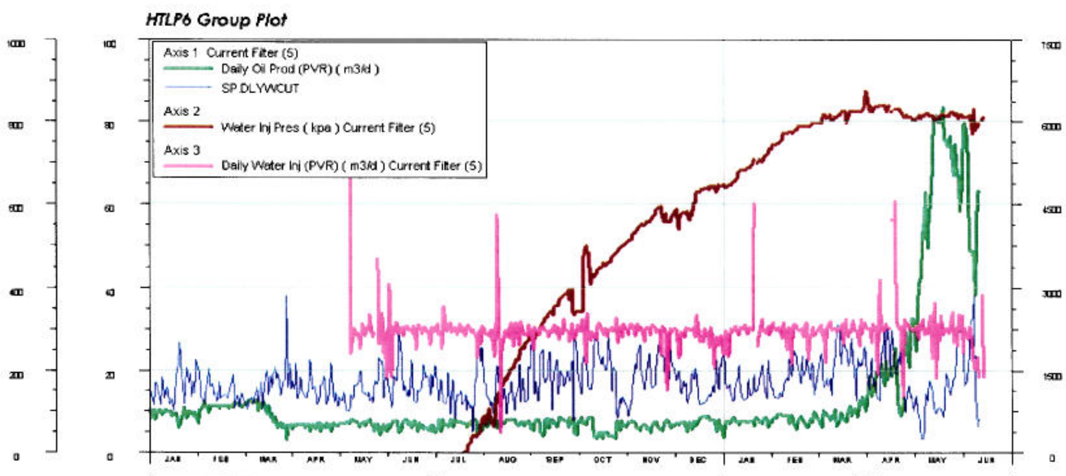
The 14-34 producer which offsets the 15-34 injector on the West has begun to show production response without any significant changes in cut. As such CNRL believes that we have not developed breakthrough but are seeing the pressure support forecasted at the beginning of the polymer flood.



The greatest production response has been observed at the 15-34 producer. Intuitively this makes sense as this producer is in the middle of the two polymer injectors and thus is receiving support from both directions. The response at this well has been better than originally expected and continues to develop as operations, such as upsizing the pump, make lowering the pumping fluid level easier.

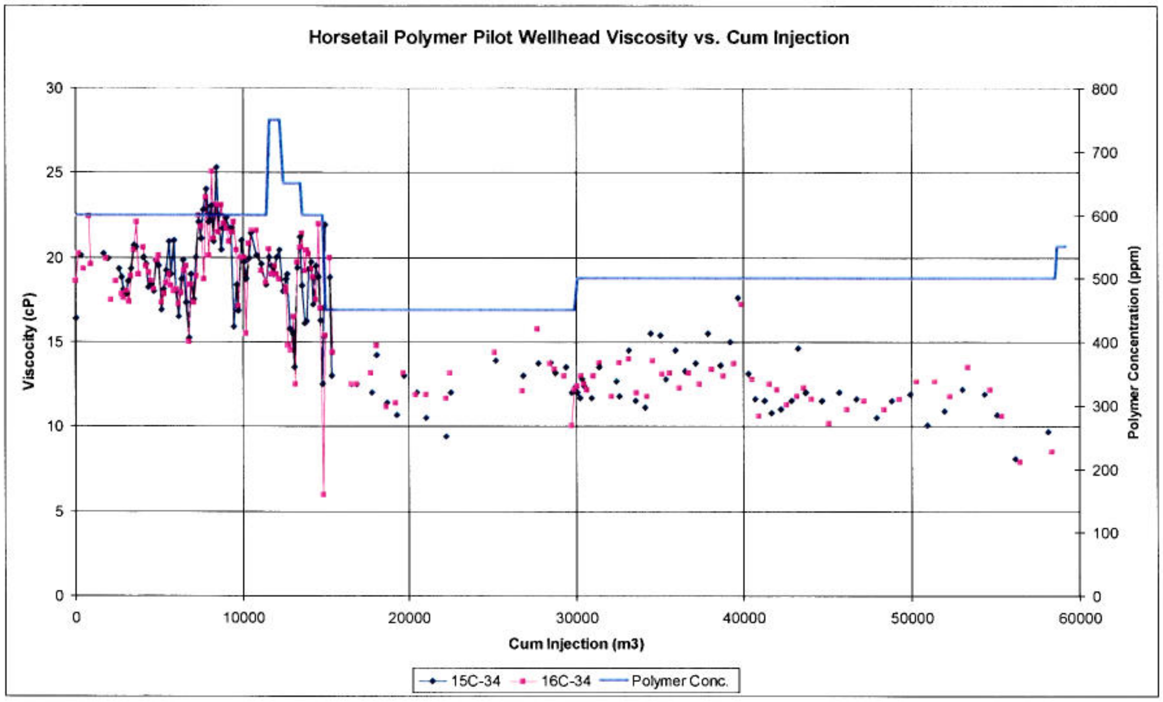


The 16-34 well on the far East end of the pad has not yet seen discernable production response. At this time CNRL does not have a conclusive reason for the lack of response and there is no reason to expect response will not develop as the reservoir receives more support and the pressure normalizes throughout.



The above plot is the grouped pad including all pilot wells. As can be seen the production response (oil shown in green) has been substantial in the past months. This is encouraging given the water cut (shown in blue) is for all purposes unchanged. The response to date supports the theory being tested that the polymer will allow for pressure response without catastrophic break though early in the program. The project is still in the early stages of response and vigilant monitoring continues. The most recent downward spikes in oil production are tied to the pump changes where the 14-34 well was down for the change.

Wellhead Fluid Composition



The above graph illustrates the wellhead viscosity of the polymer mixture being injected. The blue line corresponds to the polymer concentration used to achieve the desired level of viscosity. The step change in concentration at the 30000m3 mark is the switch to lower molecular weight polymer, hence a higher concentration of polymer for the same viscosity.

Predicted Vs Actual Performance (Simulation Work)

Early in 2006 IFP produced an updated set of predictive runs to better match the actual pressure profiles of the polymer injectors. Originally the simulations predicted a much more gradual rise in pressure over time. Changes to estimates in rock compressibility and absolute permeability have allowed much better history matching with the data obtained over the past year.

Details are presented in the IFP report, included as Appendix A.

Pilot economics to date

The following information is all contained in Appendix B:

- Sales volumes of natural gas and by-products.
- Revenue.
- Capital costs (include a listing of items with installed cost greater than $10,000).
- Direct and indirect operating costs by category (e.g. fuel, injectant costs, electricity).
- Crown royalties, applicable freehold royalties, and taxes.
- Cash flow.
- Cumulative project costs and net revenue.
- Explanation of material deviations from budgeted costs.

The two files included contain all operating and capital related expenses by month.

Facilities

Facilities at the polymer pilot site have not been changed at all since installation and commencement of injection. All plans and process diagrams submitted with the original application should be considered valid.

Environment/Regulatory/Compliance

To demonstrate compliance, CNRL has included all associated approvals received for the polymer pilot in Appendix C. These include:

1. Alberta Energy and Utilities Board Approval #10147B for Enhanced Oil Recovery (Polymer Injection Scheme)
2. Alberta Energy and Utilities Board Approval for Application 1418578 (Request for Increase of Maximum Allowable Wellhead Injection Pressure) at Pilot Polymer Flood Injector Wells
3. Alberta Environment Water Source Well Licence Documentation

CNRL is fully in compliance with all regulatory agencies; all applications necessary for operation have been received.

Safety remains a high priority for CNRL and all personnel operating on site are versed in the emergency procedures associated with field operation and all polymer plant specific issues. The emergency response plan for the field includes the polymer pilot pad and all procedures are reviewed periodically to ensure new operating issues and concerns are addressed.

Future Operating Plan

Milestones

- Completed coreflood studies, polymer type selection and initial reservoir simulation. Dec 2004 √
- Project startup occurred May 3, 2005. Commissioned injection facility and commenced injection of polymer/water mixture. √
- Attaining cumulative liquid voidage replacement ratio of 1.0 and first production response. Estimate June 2006. √
- Attaining peak oil production rate of 550 bopd from the pilot project. Estimate July to September 2006.
- Switching from polymer to water injection. Estimate early 2007.
- Obtaining sufficient production data after first polymer flood response to extrapolate results to an ultimate recovery. Estimate Summer 2008. Sufficient data to extrapolate to ultimate recovery will increase certainty in success of commercial operations and allow more accurate prediction of commercial volumes for purposes of royalty calculation. Using the North Horsetail Waterflood project to the North of the polymer pilot as a suitable analogy would suggest that even after 3 years of waterflood we are still experiencing the plateau making it difficult to predict ultimate recoveries. For this reason the timing of this milestone was pushed to the summer of 2008 compared to summer of 2007 in the original application.

Deliverables

- Proof of applicability of polymer flooding as secondary recovery mechanism to increase oil recovery and minimize water use in heavy and medium oil reservoirs similar to the Pelican Lake Wabiskaw reservoir. Proof of success will lead to greatly increased use of polymer flooding, producing oil reserves which would otherwise remain unrecovered.
- Accurate estimates of ultimate recovery factors attainable using polymer flooding in reservoirs of this type.
- Polymer design strategy and optimized operating practices.
- Documentation and resolution of technical problems which may arise during polymer flooding.

Thus far the major operating changes have been motivated primarily by concerns regarding pressure response. Now that the pilot has moved past the fillup stage the hope is that focus can be placed on cost optimization and maximizing production response. Part of the cost optimization strategy will be in determining the timing for the switch from polymer injection to water injection. This will greatly reduce the cost per barrel injected while maintaining the pressure in the reservoir and aiding recovery of the oil resource.

Salvage Update

At such time as abandonment's become necessary all government requirements will be observed in the process.

Interpretations and Conclusions

The subject polymer pilot is progressing towards developing a picture of economic and technical feasibility. The pilot is early in it's response and there are still a number of critical questions to be answered but to date the response has been encouraging.

CNRL feels that progress has been made in terms of addressing operability of the polymer injection skid. There have been no modifications necessary physically and the injection strategy is continuously under scrutiny to ensure that the correct path is being taken to ensure reservoir pressure maintenance without sacrificing watercut at the production wells. The variation in the polymer concentration and molecular weight has aided in refining the strategy going forward.

The challenges that exist with respect to the pilot centre on being the trial run for the polymer injection. Without analogous patterns that have polymer injection there is no basis for comparison. Every effort is being made to make changes to one variable at a time so that there is an easy to establish cause-and-effect trend with the data. Test frequency and data accuracy has been paramount to the success of the pilot and continues to be a high priority as the project moves forward. This pilot will serve as the baseline for future expansion and CNRL maintains it's commitment to the integrity of the data being collected on this pilot.

Technical and economic viability are constantly being assessed. At this early stage in the pilot there is evidence of response but technical success will only be determined after a sustained peak has been obtained. Likewise the economic success of the project is difficult to determine prior to going into decline as the ultimate recoveries have an enormous impact on the economic feasibility. The response to date is encouraging and has indicated the premise for the flood is sound. Time will be the measure of future viability as more data is collected and trends are established.

If successful there are a number of expansion locations available in Brintnell. If recovery trends as forecasted in our reserves booking for this pilot then there are numerous areas in the field where this technology may be beneficial. The low primary recovery in Brintnell suggests a large opportunity and if this pilot does prove up the viability of polymer flooding higher viscosity oil then CNRL sees opportunities in large tracks of primary developed parts of the field. One of the goals of this pilot has always been to expand the window of viscosity that secondary recovery processes can target. Where possible the field is already under waterflood with success and CNRL eagerly awaits the data to confirm that polymer flood will widen our window of application to allow for polymer flooding in areas of Brintnell unsuitable for waterflood.