
Final Technical Report

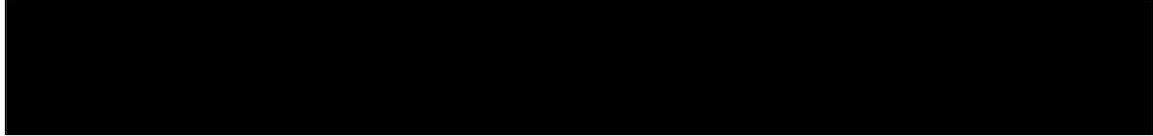
Title Page

The Use of Acid Stimulation for Restoring to Production Shut-in Oil Fields

Grant Cooperative Agreement

No. DE-FG26-03NT 15432

Prepared by Richard C. Russell, Project Director



St. James Oil Corporation

The Use of Acid Stimulation for Restoring to Production Shut-in Oil Fields



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ABSTRACT

High operating costs and low oil prices caused oil and gas production from the St. James lease to be shut in early 1998. The St. James lease is located in the Las Cienegas field in an historic area of Los Angeles California approximately two (2) miles from the downtown Civic Center.

The principal goal of this DOE project is to show how long-term shut-in oil and gas wells can be returned to profitable operation. This goal is aided by improved oil and gas prices and the use of modern stimulation technology.

Low oil and gas prices in 1998-1999 led to thousands of oil wells being shut-in throughout the United States. Based upon the premise that oil and gas prices will remain relatively stable in the future, revitalizing shut-in oil and gas wells is now an attractive option for many operators.

The effort and expense required to return a shut-in well to production depends, to a large extent, on its condition at the time of shut-in and the efforts taken to preserve the well's productivity while it was shut-in. Obviously, if a well was shut-in because of an equipment failure (tubing leak, pump failure, etc.), the mechanical problem must be corrected first. However, wells with no obvious problem at the time of shut-in other than poor economics – most likely have developed problems during the shut-in period.

St. James' experience has indicted that wells in the Las Cienegas field, which have been shut-in for a long period of time, in this case more than seven (7) years and are returned to production often produce at a rate of 30-50% less than prior rates. Scale deposition caused by filtrate invasion has been found to be the major damage mechanism. Other production-impairment mechanisms are believed to be fines migration and clay dispersion and swelling.

Project Description/Accomplishments

Five Las Cienegas wells, all of which have a high tendency to form calcium carbonate scale were carefully selected for returning to production. A program was set up to acid stimulate these five wells after production had been restored and tested.

Laboratory and field tests indicate, for this field and other surrounding fields that the mud acid systems can cause a matrix breakdown and further well bore damage. Most treatments in this field using a mud acid have an average life of less than six months.

There are stimulation techniques and materials now available that often minimize these damage factors. One technique St. James used for their acid stimulation program was to modify the hydrochloric acid used for scale removal and perforation cleanout by adding phosphonic acid to the treating chemical. The phosphonic acid reacts with aluminum in clays and feldspar to form a temporary protective film, thus allowing deeper penetration and more effective reaction on the migratory silicates and other fines. Another side benefit of the phosphonic acid is its ability to inhibit the formation of calcium carbonate scale.

Well work on the five wells was expected to be completed within one year of the project start. Unfortunately, new metering and sampling and pipeline equipments required by the Southern California Gas (SCG) delayed this project.

Currently, all five of the test wells have been acid stimulated and restored to production and initial production rates have been established. Initial tests demonstrate that modified hydrochloric acid system with phosphonic acid can be used to successfully stimulate the wells and increase oil and gas production. The stimulation of production from the five (5) wells has restored the total St. James lease to profitable status.

Economics of Project

1. The total cost of this project to restore a shut-in oil field to production and acid stimulate 5 wells cost \$306,531.
2. The five (5) wells that were acid stimulated after being placed on production provided approximately \$150,000 incremental profit in the first three months after acid stimulation.
3. The actual acid treatment costs for the five (5) wells totaled \$136,077, which is equal to an approximate payout period of 83 days.
4. The large number of wells shut-in during the price slump are a large potential resource that can be rapidly developed. Economically developing a shut-in well should begin by carefully assessing its remaining potential and evaluation all remedial repairs or workover needed for the entire well system. Such an evaluation will show that many of these wells can be economically restored to production in today's oil price environment.

St. James was also granted a Pump III project, in cooperation with the Interstate Oil and Gas Compact Commission (IOGCC) and the California Oil Producer's Electricity Cooperative (COPE), the California Energy Commission (CEC) and the California South Coast Air Quality Management District (SCAQMD). This project resulted in installation of three micro turbines to provide power to the Las Cienegas field wells.

The three (3) micro turbines are fully operational and are using natural gas for fuel. The fuel used by the micro turbine does not meet sale quality requirements for Southern California Gas but is ideal for the micro turbines to generate power for the wells and lease.

Summary – Benefits/Impacts

The well stimulation program, which includes the use of chemically modified hydrochloric and phosphonic acids, has been very effective in dissolving many types of scale. The phosphonic acid reacts with aluminum in clay and feldspars to form a temporary protective coating, which then allows a deeper penetration and more effective treatment than the hydrochloric acid alone. The procedure has broad application, particularly in California sandstone formations, where thousands of wells were shut-in in the late 1990's and early 2000's. There are still significant reserves of recoverable oil and gas in place that can be recovered by modern stimulation methods and technology. Some of these new techniques can be used to prevent the pre-mature abandonment of thousands of wells that in the past were not economic to operate.

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EXECUTIVE SUMMARY

Included in the body of the abstract – nothing specific to this report

EXPERIMENTAL

The Grant Program provided for five (5) wells to be acid stimulated to aid in establishing commercial production on a shut in oil field. The St. James #6 and St. James #14 were successfully acid stimulated in the fourth quarter of 2004. The St. James #8, 10 and 19 wells were completed in the first quarter of 2005.

All fieldwork to complete the grant program has now been completed. See listing below for date each well was acid stimulated.

Updated well test data, production reports and individual well cost reports are enclosed for your status reviews.

<u>Well Number</u>	<u>Date Completed</u>
St. James #6	08-30-2004
St. James #14	11-18-2004
St. James #10	02-21-2005
St. James #8	01-19-2005
St. James #19	03-21-2005

RESULTS AND DISCUSSION

Currently, all five of the test wells have been acid stimulated and restored to production and initial production rates have been established. Initial tests demonstrate that modified hydrochloric acid system with phosphonic acid can be used to successfully stimulate the wells and increase oil and gas production. The stimulation of production from the five (5) wells has restored the total St. James lease to profitable status.

Table 1
Oil Rate Response to Stimulation Treatment

5 Wells (St. James 6, 14, 8, 10, 19)

Well No. St. James Lease	Date Treated	Prior to Treatment (1)		Months Since Treatment	Oil and Gas Rate Since Acid Treatment		Average Increase in Oil and Gas Rate Since Acid Treatment	
		BOPD	MCFD		BOPD	MCFD	BOPD	MCFD
SJ 6	08-30-04	6.77	15.9	9.1	34.68	69.77	27.91	53.87
SJ 14	11-18-04	3.39	7.94	6.4	4.19	9.19	0.8	1.25
SJ 8	01-18-05	2.26	5.26	4.4	5.94	11.94	3.68	6.68
SJ 10	02-15-05	6.77	15.9	3.5	22.97	46.23	16.2	30.33
SJ 19	03-21-05	2.26	5.26	2.4	6.61	13.29	4.35	8.03
	Total	21.45	50.26	AVG 5.16	74.39	150.42	52.94	100.16

Note: (1) Average oil and gas rates for the last three months prior to shut down (Jan 1998)
(2) Average daily oil and gas rates as of 06-01-05

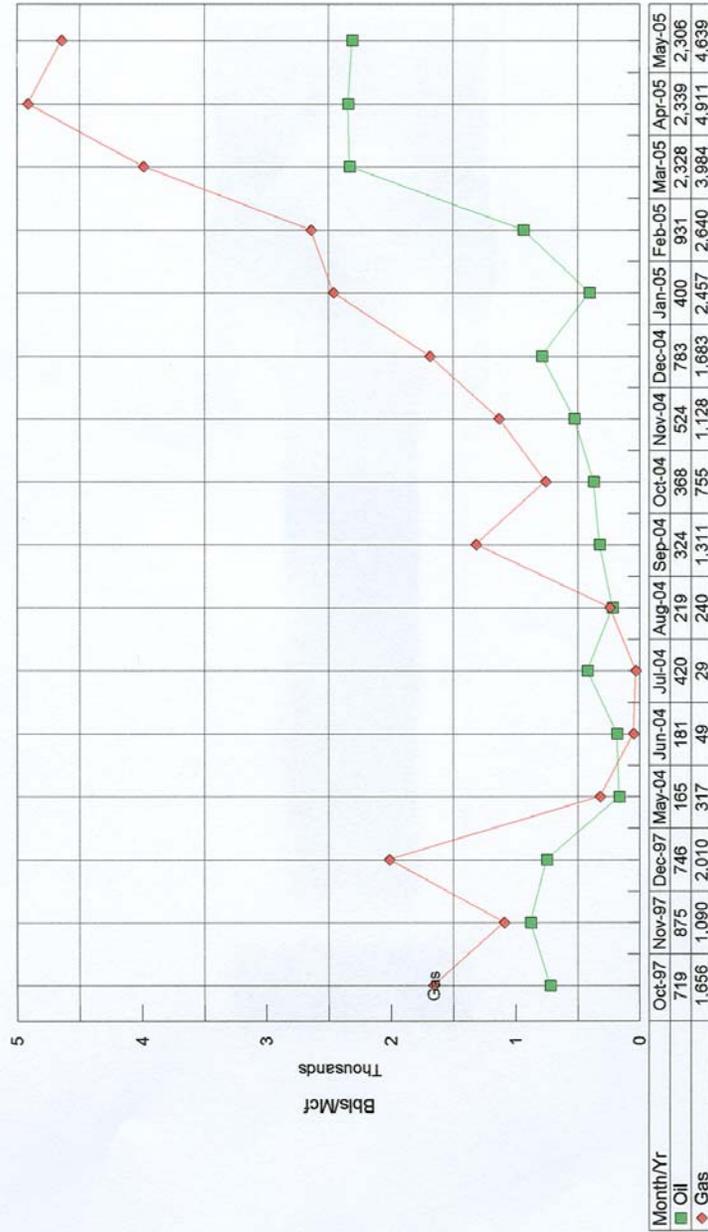
CONCLUSION

The well stimulation program, which includes the use of chemically modified hydrochloric and phosphonic acids, has been very effective in dissolving many types of scale. The phosphonic acid reacts with aluminum in clay and feldspars to form a temporary protective coating, which then allows a deeper penetration and more effective treatment than the hydrochloric acid alone. The procedure has broad application, particularly in California sandstone formations, where thousands of wells were shut-in in the late 1990's and early 2000's. There are still significant reserves of recoverable oil and gas in place that can be recovered by modern stimulation methods and technology. Some of these new techniques can be used to prevent the pre-mature abandonment of thousands of wells that in the past were not economic to operate.

REFERENCES

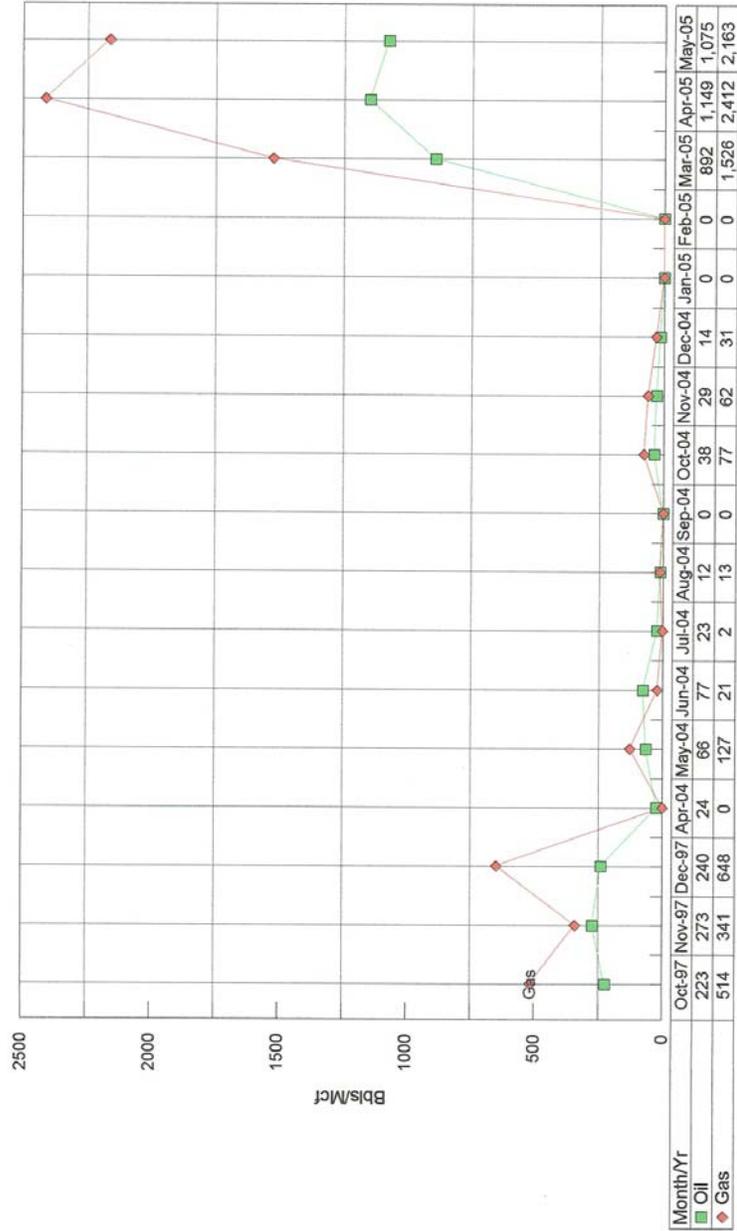
Technical Progress Report dated December 2004

St. James Oil Corporation
Summary of Acid Stimulation Wells



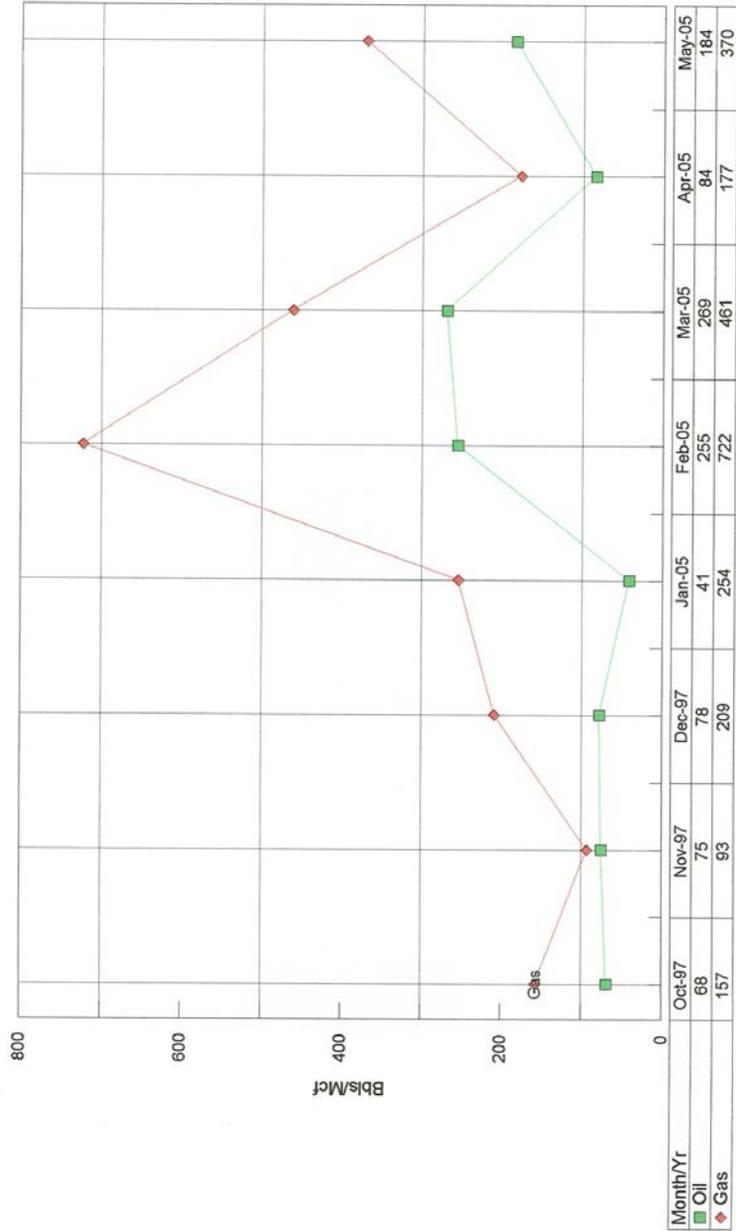
St. James Lease
Wells 6, 8, 10, 14, 19

St. James Oil Corporation
Monthly Production



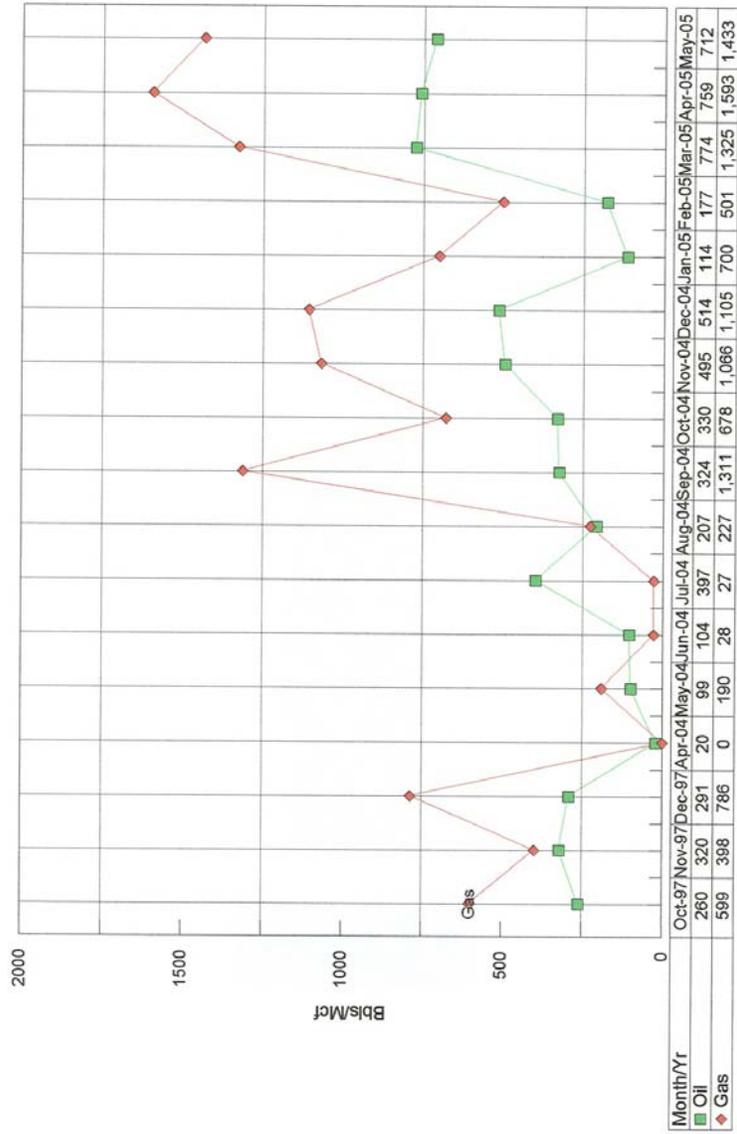
St. James #6

St. James Oil Corporation
Monthly Production



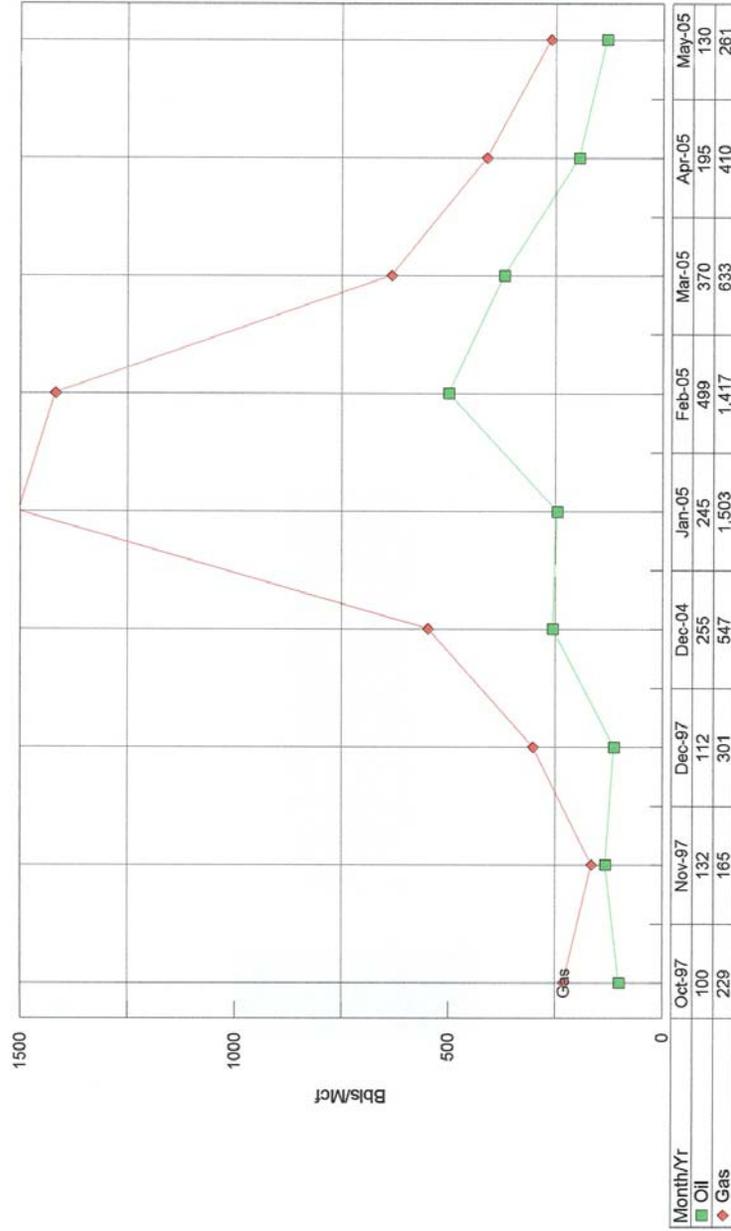
St. James #8

St. James Oil Corporation
Monthly Production



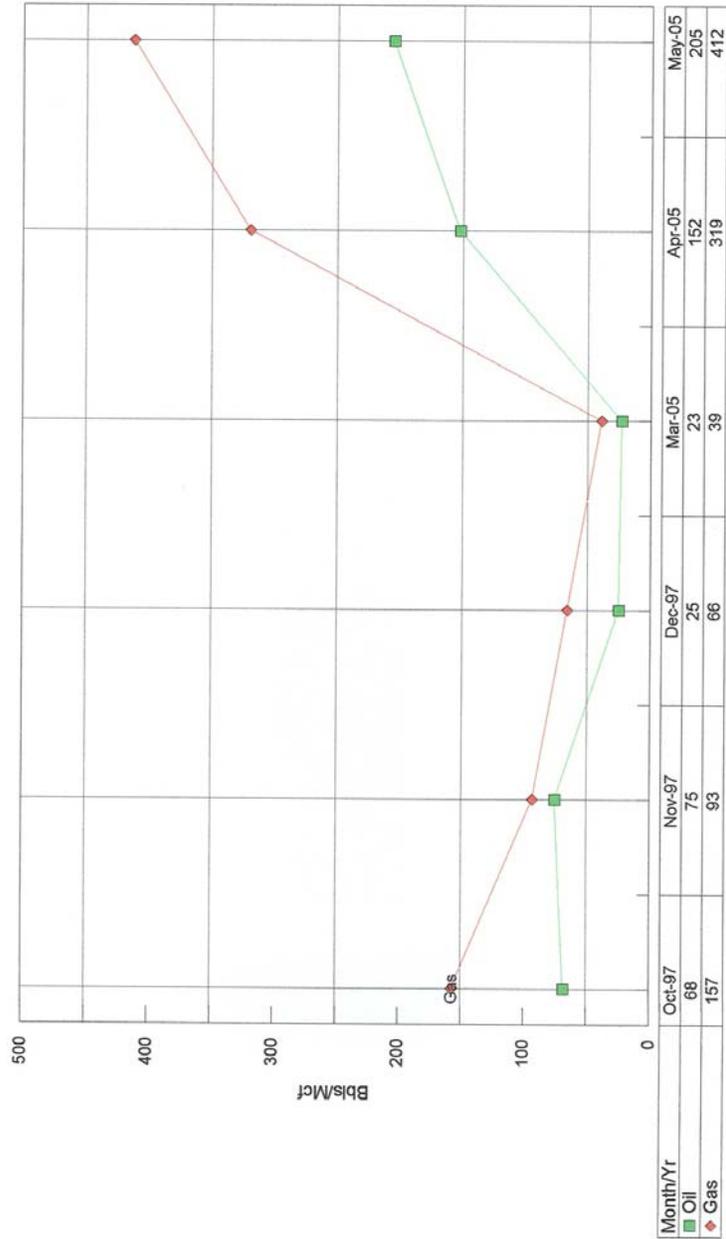
St. James #10

St. James Oil Corporation
Monthly Production

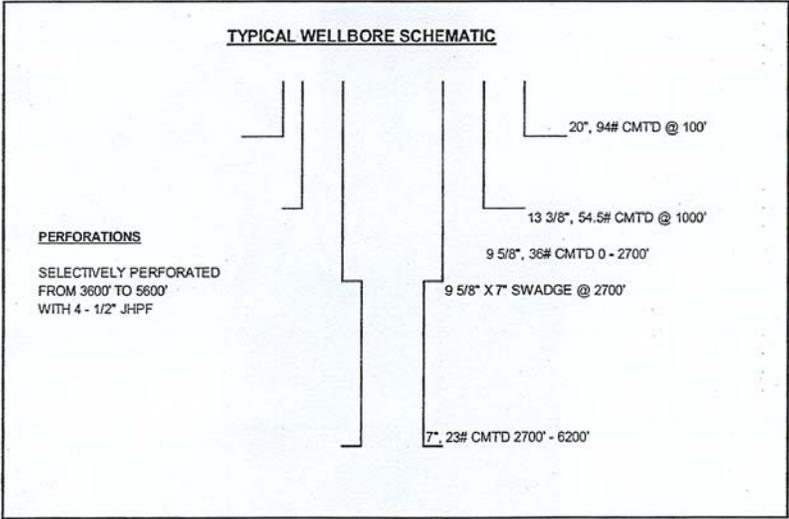
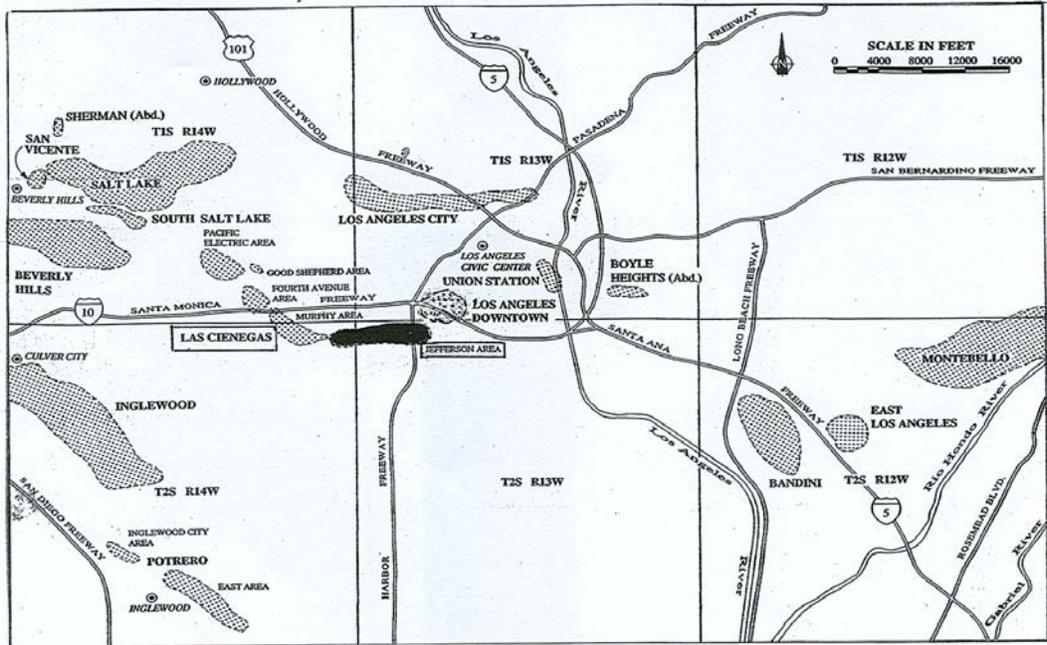


St. James #14

St. James Oil Corporation
Monthly Production



St. James #19



Geology

- The field is on east-west trending anticlinal structure
- Upper Miocene – Puente Formation
- Hydrocarbons trapped in the area by faulted anticlinal closures
- Reservoir section consist of turbidite sands in three distinct zones
- Hill, Broadway and Massive
- The current acid stimulation program concentrated on the Broadway zone
- Broadway zone is composed of thinly interbedded sands and shales
- Oil production is from an area of 250 acres
- Wells range in depth from 1800 feet to 4900 feet vertical sub area

Reservoir Properties – Broadway Zone

• Depth	Upper 2900' – Middle 3100' – Lower 3500'
• Porosity (%)	30
• Permeability (millidaries)	179
• Initial reservoir pressure (psi)	1590
• Initial reservoir temperature (F)	140
• Oil Gravity (api)	30
• Solution GOR (scf/stb)	1578
• Gas Heating Value (btu/cu.ft.)	1340
• Water Salinity, Nacl (ppm)	23,450

Typical Stimulation Procedure

- Carefully conduct well tests prior to well stimulation
- Move in Baker Type Tank or available storage facility to evaluate the fluids from the stimulated well
- Pull pump and tubing. (tbg tested – 5000 psi)
- Run casing scraper,
 - a. To locate any casing restrictions
 - b. To locate top of fill
 - c. Clean out fill (if fill is above proposed wash zone)
 - d. Clean casing wall (minimize leakage of wash tool)
- 1st STAGE
- Run circulation wash tool and stimulate per the following procedure using selected wash intervals.
- Use 2250 gallons 10% HCL and phosphonic Acid (15 gallons/foot) Note: maximum surface pressure 2000 psi and 2 BPM injection rate, circulate wash from bottom up.
- 2nd STAGE
- Run circulation wash tool and stimulate selected wash intervals with 2250 gallons of 10% HCL and phosphonic Acid HV) - scale inhibitor. Displace tubing volume with filtered lease water.
- Pull circulating wash tool above liner top and secure well for the night.
- Pull out of hole with wash tool
- Run pump assembly
- Place well on production into Baker Tank. Evaluate produced fluids for unspent acid. Obtain PH readings daily
- Note: Secure samples of the inhibited acid before and after performing the job.
- The following protective additives were added to the acid stimulation chemicals to protect against corrosion, emulsion and sludge.
 - a. 0.2% CL-25 (corrosion inhibitor)
 - b. 0.2% NE 940 (now-emulsifier/wetting agent)
 - c. 0.6% Ferrotrol 300L (iron control)

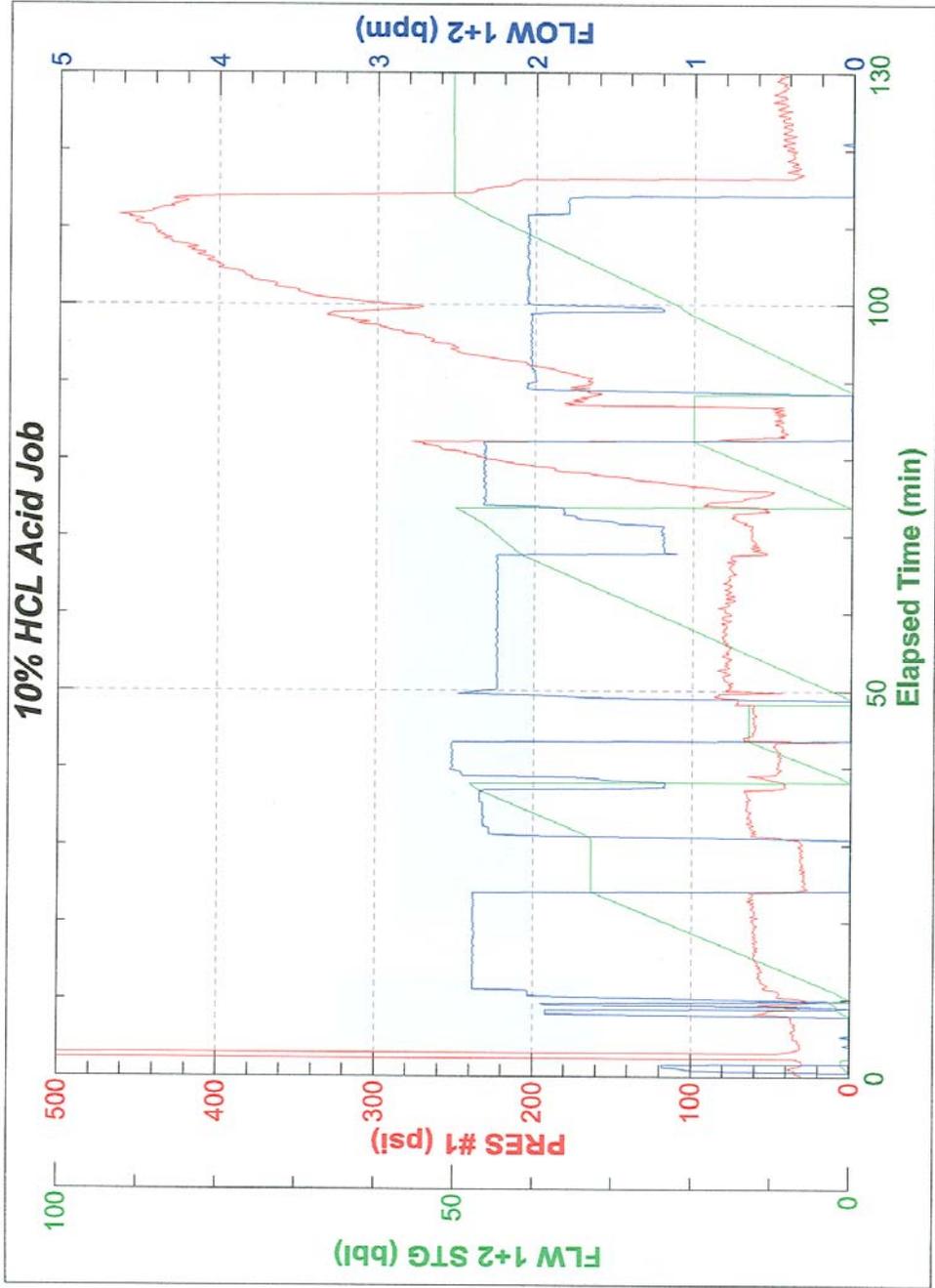
Stimulation Procedure continued

- d. 0.8% Ferrotrol 270L (iron reducing agent)
- e. 0.2% Ferrotrol 271L (iron reducing agent catalyst)
- f. 1.2% AS-6 (anti-sludge agent)

➤February 1, 2004 corrosion, sludge and emulsion testing were performed on oil samples, including complete water analysis of lease water. Results of the tests indicated that by using the above listed agents no sludge or emulsion was detected after 2 hrs @ 130 degrees F. Corrosion loss was also found to be in favorable limits.

Acid Stimulation - Pressure & Flow Rate Evaluation Well SJ#6

BJ BJ Services JobMaster Program Version 3.00
Job Number: St. James Oil Corp
Customer: St. James Oil Corp
Well Name: St James #6



Job Start: Tuesday, August 31, 2004

BJ Services