Real-time Tracer Monitoring of Reservoir Stimulation Procedures Via Electronic Wireline and Telemetry Data Transmission

ANNUAL TECHNICAL PROGRESS REPORT

June 2001 – June 2002

Realtimezone- George Scott III

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ABSTRACT: TECHNICAL PROGRESS REPORT

Annual Report: June 2001 – June 2002

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Ongoing Phase 2 work comprises the development and field-testing of a real-time reservoir stimulation diagnostic system. Phase 3 work commenced in June 2001, and involved conducting research, development and field-testing of real-time enhanced dual-fluid stimulation processes. Experimental field-testing to date includes three well tests. Application of these real-time stimulation processes and diagnostic technologies has been technically successful with commercial production from the "marginal" reservoirs in the first two well tests. The third well test proved downhole-mixing is an efficient process for acid stimulation of a carbonate reservoir that produced oil and gas with 2200 psi bottomhole reservoir pressure, however, subsequent shut-in pressure testing indicated the reservoir was characterized by low-permeability.

Realtimezone continues to seek patent protection in foreign markets to the benefit of both RTZ and NETL. Realtimezone and the NETL have licensed the United States patented to Halliburton Energy Services (HES). Ongoing Phase 2 and Phase 3 field-testing continues to confirm applications of both real-time technologies, from well testing conducted over the last 12-month work period and including well test scheduled for year-end of 2002.

Technical data transfer to industry is ongoing via Internet tech-transfer, public presentations and industry publications. Final Phase 3 test work will be focused on further field-testing the innovational process of blending stimulation fluids downhole. This system provides a number of advantages in comparison to older industry fracturing techniques and allows the operator to control reservoir fracture propagation and concentrations of proppant placed in the reservoir, in real-time. Another observed advantage is that lower friction pressures result, which results in lower pump treating pressures and safer reservoir hydraulic fracturing jobs.

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INTRODUCTION

Realtimezone's Phase 2 & 3 research and development objectives comprise two main real-time enhanced projects; the construction and field-testing of a reservoir fracturing diagnostic system, and field-testing and commercialization of a novel reservoir stimulation processes integrating downhole-blended stimulation processes.

The National Energy Technology Laboratory supports a significant portion of this work. The timelines for the various project tasks are illustrated (see Exhibit One) and further elaborated on in this report. The developed field-proven real-time technologies have direct application towards the enhanced recovery of natural gas and oil in the Unites States, including onshore and offshore reservoirs.

Since initial Phase 1 work conducted in 1999, RTZ's Phase 2 research and field-testing work has principally comprised research and development work related to development of a real-time tracer diagnostic system for monitoring reservoir-fracturing procedures. Phase 3 project work principally involves development and testing of proprietary concepts related to real-time enhanced, downhole-blended reservoir stimulation processes. To date, three well tests have been conducted related to real-time dual-fluid stimulation. These concepts are further described in more specific detail in a United States patent that publishes this year by George Scott and Gary Covatch (NETL).

Realtimezone and NETL licensed the developed real-time stimulation processes to a major energy service company (Halliburton Energy Services). In addition, it is anticipated that the real-time tracer diagnostic system will also ultimately be licensed to major energy service providers, upon final development and well testing work scheduled for the next 12-month period. Technical data transfer for this innovative stimulation process is ongoing. RTZ gave two major presentations in 2002 to the AAPG in Ruidoso, New Mexico, and at a NETL Workshop in Denver, Colorado. A third talk is scheduled for the Society of Petroleum Engineers (SPE) in San Antonio, Texas, in October, 2002.

EXHIBIT ONE- Phase 2 & 3 Project Task Timelines

PHASE 2 & 3				***Year Ending June 2002***			
Project timeline							
June 1999		**June 2000**		**June 2001**		**June 2002**	
	MO 1-6	MO 7-12	MO 13-18	MO 19-24	MO 25-30	MO 31-36	
Task 5							
Task 6							
Task 7							
Task8							
Task9							
Task10							
Task 11							
Task 12							
Task 13							
Task 14							
Task 15							
Task 16							
	Dec 1999		**Dec 2000**		**Dec 2001**		**Dec 2002**

EXECUTIVE SUMMARY

(DE-FC26-99FT40129)

This research project has two major objectives: Phase 2 research and development of a real-time reservoir stimulation diagnostic system via electronic data transmission, and Phase 3 research and development of a proprietary dual-fluid, downhole-blended stimulation process. To date this work has field tested and proven various applications of both real-time technologies. The successful test results will lead to new developments in the enhanced recovery of petroleum reserves in basins throughout the United States.

Realtimezone's research and development work comprises field-testing and refinement of real-time optimized well stimulation processes, and includes work focused on downhole-mixed stimulation fluids and emulsions. These developed real-time fracturing processes will provide the industry numerous advantages including enhanced reservoir fracture stimulation treatments. These novel concepts will be further well tested later this year. Upon refinement, these real-time fracturing processes by their application will directly increase reservoir productivity in numerous fields throughout the United States, both onshore and offshore, and in both vertical and horizontal wells.

Project work includes experimental well testing that if successful, will continue to confirm the efficacy of downhole-mixed composite fluids. This real-time downhole-mixed process is efficient for fracturing low-permeability reservoirs and at substantially lower treating pressures, which is significant in an industry where old tubulars and pressure-restricted casing is common. Another important factor is the real-time mechanism provided by downhole-mixing for instantaneously controlling changes in fluid rheology and proppant concentrations at the wellbore-fracture interface. These real-time changes are achieved by the mixing of fluids from both casing and tubing. Efficient mixing occurs in the downhole region of the wellbore between the different fluids, gases, and proppant due to mechanical admixture of principally laminar flow pattern from casing annulus and the vortex flow pattern from tubing.

The downhole-mixed stimulation process allows the operator to control the distribution of proppant in the reservoir, while minimizing fracture height. As such this fracturing process may be used to prevent common stimulation problems that include "treating out of zone", which often results in a significant loss of hydrocarbon reserves that is typically irreversible

Real-time fracturing control, a multi-task objective of this work project, is desirable to minimize or prevent common reservoir stimulation problems that result in losses of otherwise proven and probable reserves. Realtimezone's technology is applicable in wells located offshore and onshore, in vertical and horizontal wells, and in both openhole and cased wells. This innovative work will be further field-tested in a fourth test well, the NGX Boggs Fee#1, near year-end, 2002.

EXPERIMENTAL

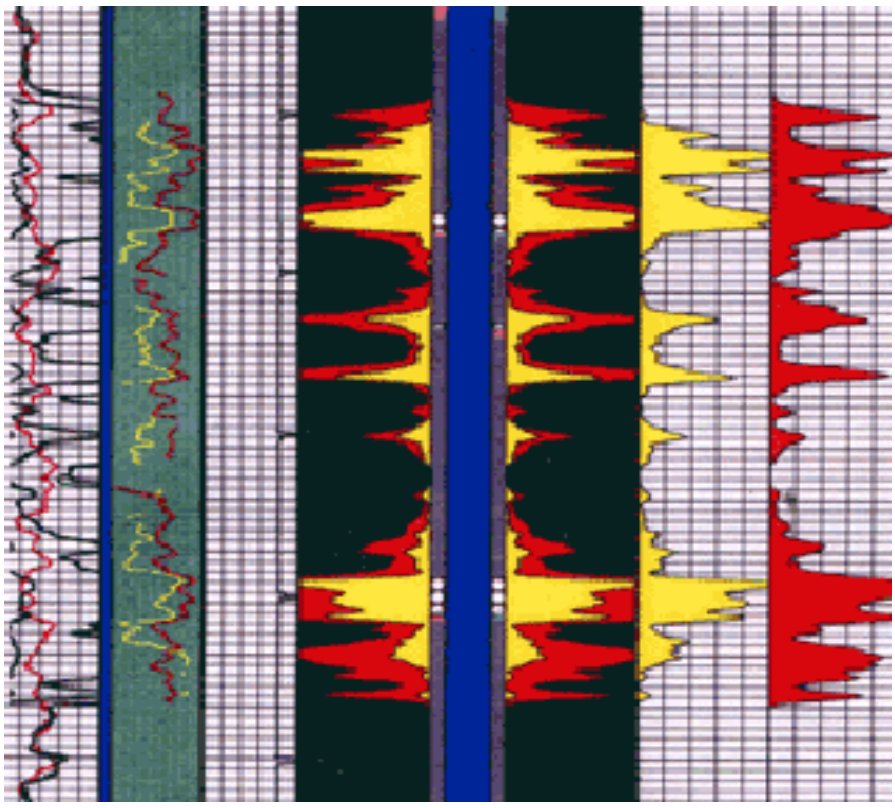
DISCUSSION of METHODS & PROCEDURAL PROCESSES

Phase 2 work effort commenced with the design of a downhole injector tool and preparations for field-testing that included establishing relations with well operators. Phase 2 work also included studying environmental compliance issues, establishing plugging bonds, liability insurance and related contracts for the test wells contract operated by NGX and other project participants, including RTZ and NETL This work further includes the ongoing protection of intellectual property by the PI to the common benefit of Realtimezone and the National Energy Technology Laboratory (NETL), who are patent royalty holders under a Licensing Agreement with Halliburton Energy Services (HES).

The well field-test operator, NGX Company, Inc., was assisted by Realtimezone in preparatory field work and in the preparation of governmental agency permits that included forms filed with the New Mexico Oil Conservation Division (NMOCD) for preparation of the field well tests. Realtimezone's Internet web site further presents the downhole-mixed technology (www.realtimezone.net) and is currently updated with nonproprietary field-test data.

To summarize well test results to date, the first field-test well, the NGX Experimental St.1., confirmed that successful real-time stimulation processes are possible using downhole-blended fluids and gas. RealtimeZone reentered and successfully field-tested the novel patent-pending real-time stimulation process involving downhole-blended CO2 and methanol-gel, with proppant. This experimental well fracturing process was tagged with multiple isotopes for post-fracture measurement of fracture height and to delineate proppant placement within the 12,300 feet tight gas reservoir. The tracer survey log (see Exhibit Two) confirmed that the treatment was successfully pumped and adequate proppant placement was achieved within the targeted reservoir zone. Subsequent production results of approximately 250 MCFGPD further confirmed that this treatment worked and the well was made commercially productive. The treating pressure chart (see Exhibit Three) also illustrates that pressures remained significantly lower than would normally be encountered with conventional surface-mixed fracturing processes.

EXHIBIT TWO- Experimental well test data: Post-fracture tracer log showing placement of fluid and proppant from a downhole-mixed stimulation treatment.



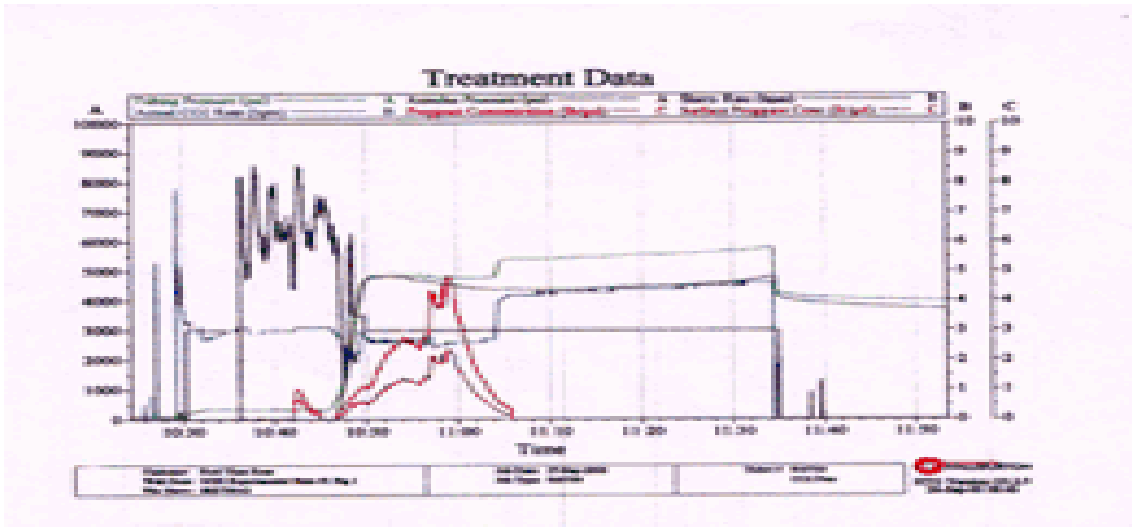


EXHIBIT THREE:
This treating pressure chart illustrates a downhole-mixed stimulation procedure with tubing pressure of less than 6,000 psi & casing pressure less than 5,000 psi.

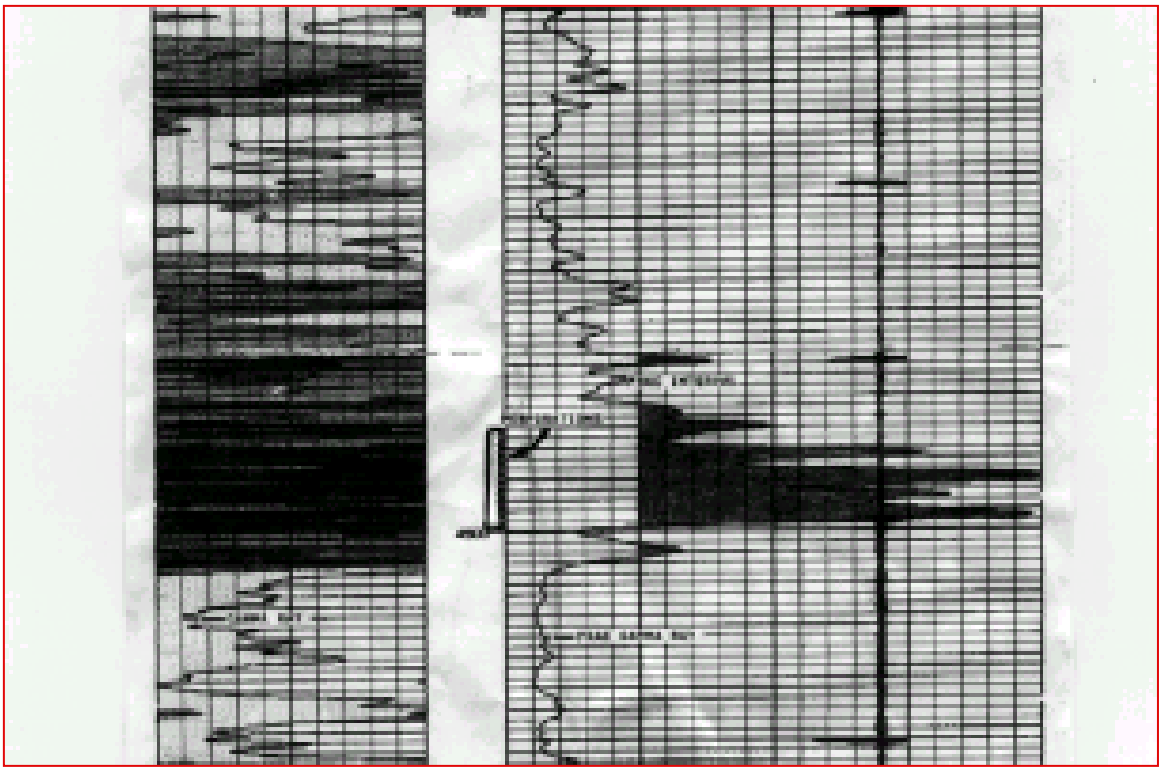
The second well test, the NGX McKee St.1 was also successful. A gelled lease oil fluid with proppant and CO2 were downhole-mixed to create a 50% foam fracturing treatment. Exhibit Four illustrates the placement of tracer in the fractured reservoir interval. Daily oil production was increased as a result of the treatment from a noncommercial well to commercial producer.

An unfortunately common characteristic of such "tight" (low-permeability) gas-bearing sandstones at this depth is that a comparatively high pressure fracturing treatment is required. As a result, typically special tubing and casing designs are required due to excessive treating pressures, which are observed when fracturing at this depth. Often, these deep reservoirs are not successfully fractured by present industry techniques due to the occurrence of excessive treating pressures, which results in a prematurely aborted treatment. As a result, substantial petroleum and particularly natural gas reserves are inefficiently stimulated. This chronic loss of reserve value is widespread in the petroleum industry. Particularly in the absence of natural reservoir fractures, virtually all low-permeability natural gas reservoirs require an adequate fracturing treatment to improve flow from the reservoir to the wellbore and surface. The stimulated recovery of natural gas from tight reservoirs is directly a function of obtaining both adequate length of induced fracture propagation *and* sufficient proppant placement therein.

The second test well, the NGX McKee St. 1, was chosen to test a dual-fluid downhole-mixed fracturing system. The design objective was to fracture stimulate the test reservoir at significantly lower treating pressures than would be normally experienced by conventional fracturing methods. Another objective was to attempt to control the distribution of proppant in the reservoir, in real-time, while minimizing fracture height. The results confirm (see exhibit four) that real-time downhole-mixed stimulation fluids (and proppant) may be ratio mixed to effectuate specific qualities of fracturing slurry rheology for minimal fracture height growth, while also reducing surface treating and pipe friction pressures.

EXHIBIT FOUR:

Gamma survey log showing downhole-mixed fracturing treatment pumped in Delaware oil reservoir at 5,100 feet.



Downhole-blending of gases, including Nitrogen, and methanol-gel result in a composite stimulation fluid that is comparable in efficiency and proppant transport to a surface-mixed gas and gelled foam treatment. However, there are numerous advantages observed with downhole-blended gas-gel composite fluids including lower fluid-pipe friction, lower pressures and reduced pump horsepower requirements. In addition, downhole-blended stimulation treatments will alleviate chronic stimulation problems including premature screenout, fluid-reservoir skin damage, excessive treating pressures, fracturing out of zone, and excessive water production.

The costs of dual-fluid well stimulation procedures would also be lower, due to reduced horsepower pumping requirements, and because less surface equipment is

required. This simple, downhole-mixed completion technology thus easily enables the well operator to realize dramatic improvements in efficiency, safety, cost savings, and reservoir fracturing success.

The downhole-mixed fracturing fluid is blended downhole to avoid excessive friction pressures that otherwise result when fluids are mixed and thickened at the surface. A composite fracturing fluid is thus created downhole prior to injection into the reservoir formation fracture

Known additives, including thickening agents, may be incorporated into the base-fluid to increase fluid viscosity, to improve proppant suspension, leak-off and to effectuate desirable rheological properties. Thorough mixing of the propping agent with the composite stimulation fluid preferably occurs immediately above or adjacent to the targeted reservoir interval where the induced reservoir fracture or fractures are propagated. A variety of problems are avoided in real-time by the simple method of downhole mixing, which provides the ability to instantaneously modify stimulation treatments by rapid changes in pump rate, fluid rheology and proppant concentrations. This inventive system typically minimizes friction pressures and thus provides lower treating pressures and higher pumping and injection rates.

By providing separate conduits for respective separate fluid compositions at the surface, composite downhole fracturing fluid combinations that might otherwise have been impractical if mixed at the surface, may be permissible. For example, a first fracturing fluid phase including carbon dioxide may be pumped down the tubing, while a second fluid phase including nitrogen, gelled aqueous fluid and proppant may be pumped down the casing annulus. The first and second fluid phases may combine and mix downhole in the casing to form a composite fracturing fluid that might otherwise have exhibited too much friction loss to have been pumped from the surface as a composite fracturing fluid.

Additional field-testing of the downhole-mixed process is scheduled to commence later this year with the re-entry and completion of the NGX Boggs Fee# 1. This next scheduled well test will also include a real-time tracer monitored fracturing treatment. Present plans are to monitor in both upward and downward vertical directions with respect to the targeted reservoir.

RESULTS AND DISCUSSION

A significant portion of this project work has been successfully conducted in three field test results obtained to date from the NGX Experimental St. 1 and NGX McKee St. 1 wells. A fourth field test is scheduled prior to year-end in the NGX Boggs Fee #1.

The ongoing development of a real-time tracer diagnostic system remains technically feasible, however, several logistical problem were encountered in the course of field test work. One problem was due to the fact that HES had just previously licensed their gamma logging tools to Corelab's ProTechnics for conversion and use in battery-powered slickline operations. As a result, the future availability of HES's wireline tools is very limited. Another complication has resulted from the fact that as a tracer provider, ProTechnics is not allowed to run their tracers through HES's smaller pump trucks. HES only allows high-pressure tagging operations, which are only available through the services of another tracer provider, Cardinal Survey. However, ProTechnics refuses to use their tracers or gamma detector equipment with Cardinal (their competitor). And Cardinal has only a single gamma detector source. As a result, Realtimezone has been forced to use Cardinal for both tracer and wireline gamma detector services, which precludes use of ProTechnics's multiple spectra gamma detector memory tool, as previously planned.

The results of ongoing research and development have led to numerous breakthrough concepts related to both the tracer diagnostic system and downhole-mixed fracturing process. Downhole-mixing concepts in particular have been developed that should simplify and revolutionize the present industry stimulation processes that are used for reservoir stimulation. It is anticipated that the fourth scheduled well test work (in Boggs Fee #1) will confirm many of these novel concepts.

Excepting crew and equipment limitations, the overall field-testing operations in 2002 have been conducted smoothly and without problems or unexpected circumstances. Field data acquisition and the results of experimental well testing were generally very successful.

Downhole mixing facilitates instant modification of the fracture treatment, and provides near instantaneous alteration of fluid viscosity and proppant concentrations at

the reservoir, in real-time. At this juncture, several additional "smart frac" processes still need to be tested. Further modeling and field-testing will assure that this technology and valuable variations of the real-time dual-fluid stimulation system become utilized on a widespread basis by industry. Developing and demonstrating the various applications of this proprietary technology, via well tests, will benefit the petroleum industry and domestic consumers alike throughout the United States.

CONCLUSION

The basic concepts of real-time tracer diagnostics and downhole-mixed reservoir stimulation procedures was recently successfully field tested by the Principal Investigator in conjunction with the operating company, NGX, RealtimeZone, and the NETL. Commercialization of this technology is potentially imminent, as Halliburton Energy Services has executed a Licensing Agreement and intends to commercially provide this technology for industry. Upon successful field test confirmation, the commercial advantages of this developed system will become evident to the industry. The cost savings provided by these technologies are significant.

The upcoming scheduled project well test work will facilitate further development of novel tracer diagnostic system and reservoir stimulation procedures that will directly result in enhanced petroleum recovery. RealtimeZone is preparing to make a presentation to the American Association of Petroleum Geologists (AAPG) to present these ideas and other publications and talks are planned to further present these concepts to industry. Commercial advantages should include lower treating pressures, lower friction pressures (and pump horsepower requirements), and real-time control of the fracturing process. Further well testing will facilitate further development of these innovative reservoir stimulation procedures, thus improving the recovery of natural gas reserves in the United States. Moreover, previously unrecoverable natural gas reserves will be harvested through applications of this novel technology.

Appendix- NETL Workshop Presentation