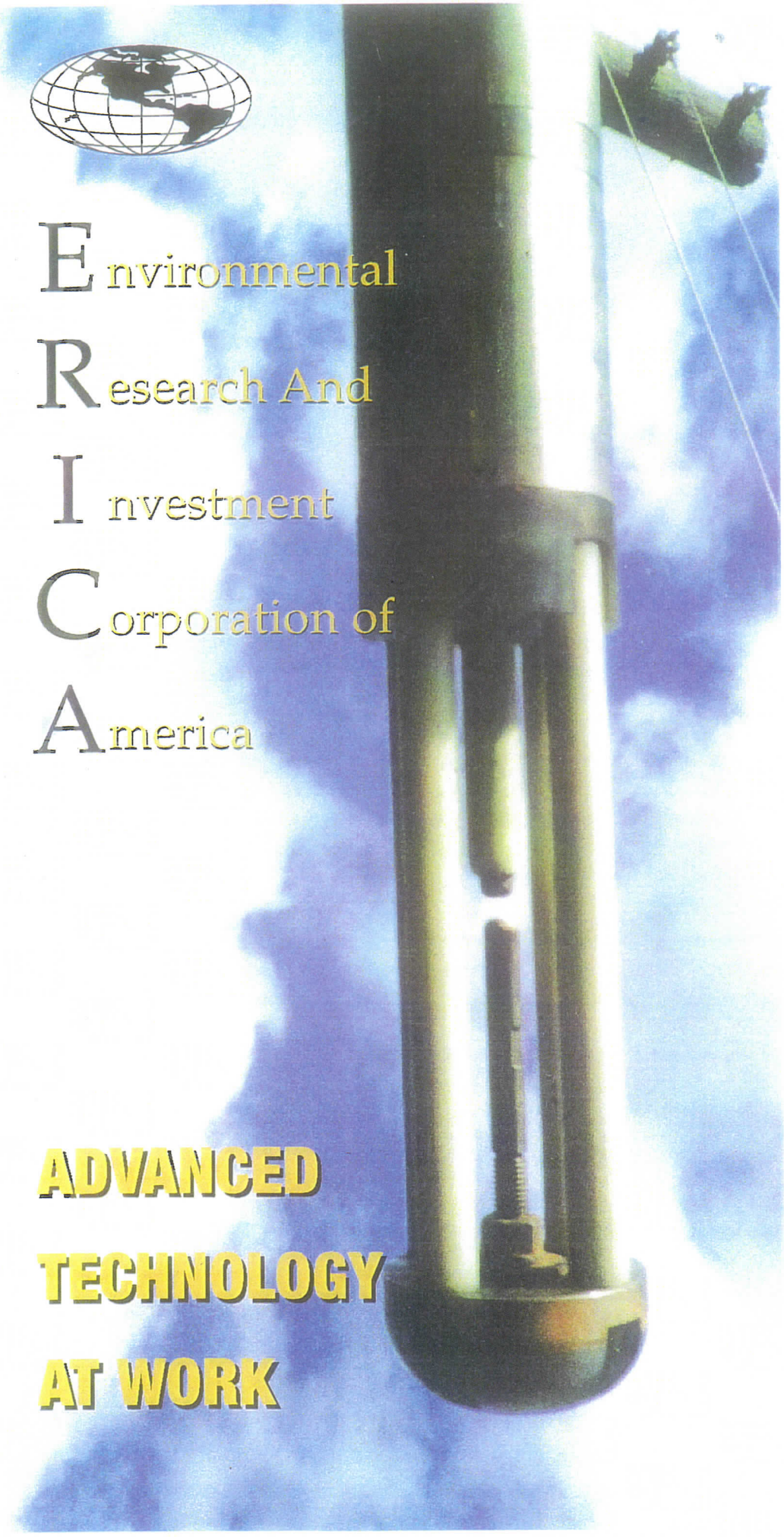
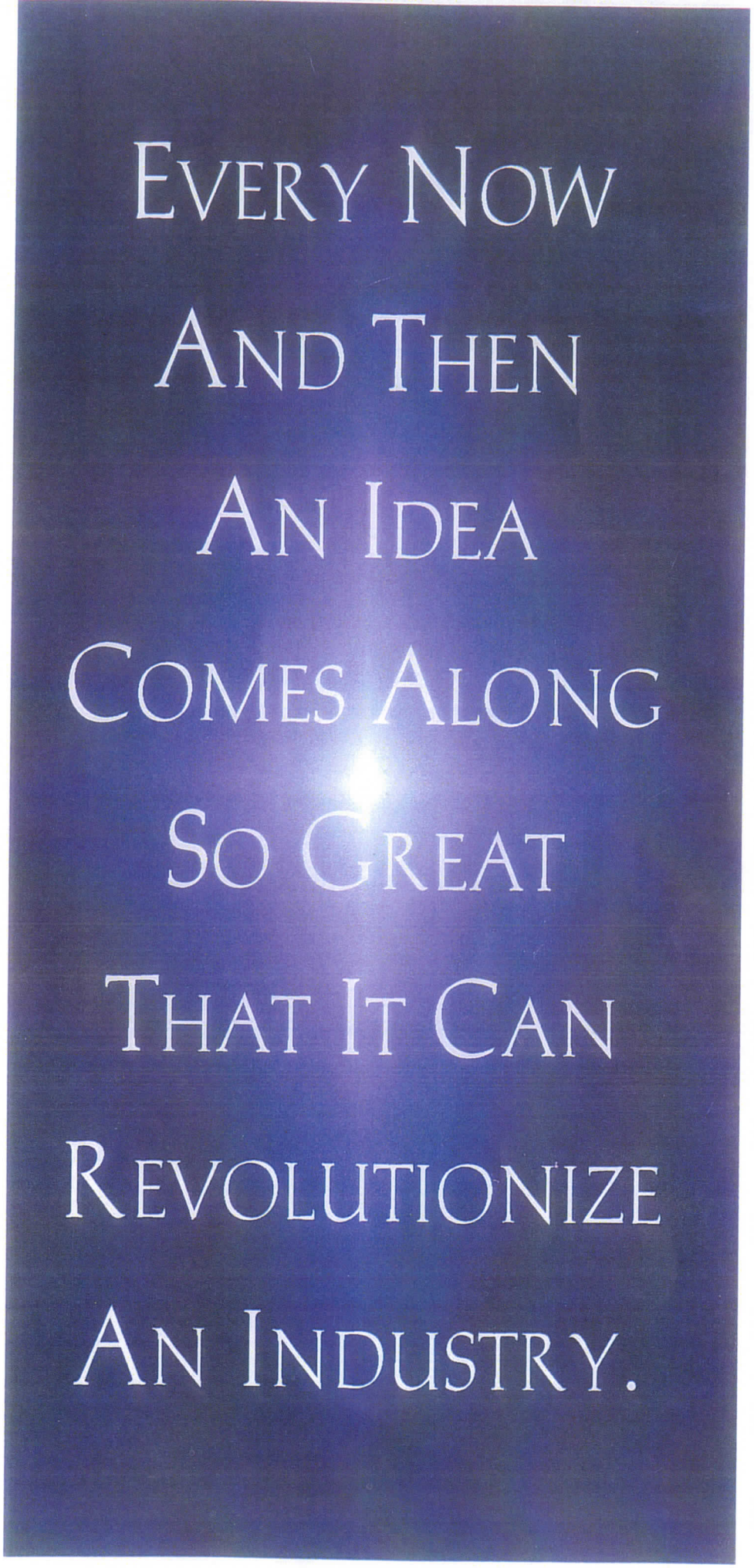


ERICA

Environmental
Research And
Investment
Corporation of
America

ADVANCED TECHNOLOGY AT WORK


EVERY NOW
AND THEN
AN IDEA
COMES ALONG
SO GREAT
THAT IT CAN
REVOLUTIONIZE
AN INDUSTRY.

CONTENTS INDEX

OIL TECHNOLOGY Since 1986

ERICA

Environmental Research & Investment Corp. of America

August 1, 2003

GENERAL BACKGROUND INFORMATION
ERICA

For the past ten years ERICA has been involved with extensive research on a pulse power down hole tool to enhance oil production and recovery. When dealing with extremely high voltage (10KV) and a very small package of 3.5 " in diameter, most components must be specifically designed and built for the down hole unit.

Although our first test was done with a crude tool it was successful in increasing the production of the wells in that field. It took the better part of five years to develop the dependable components that have now been tested and are now installed in an effective down hole tool that has been field tested at great length. The tool is not only effective in increasing oil production but it is environmentally friendly and infinitely more economical than recovery techniques currently in use.

MISSION

It is the mission of ERICA to confirm to the industry the success of the Pulse Power tool and market the tool in the United States. It is well known that there is an immediate need to increase domestic production and enhance the recoverability of oil from low producing wells and stripper wells.

This need is on the top of the Government agenda as it is directly linked with our National Security.

REQUIREMENTS

In order to prove to the industry the reliability of the tool and the fact that the tool creates a significant increase in oil production of approximately 300% it will be necessary to construct 5 new tools with an additional spare tool and then to test the 5 new tools in 5 diversified locations both geographically and geologically different.

.49 Via Paseo Del Sur
Scottsdale, AZ 85258 USA

Phone: 480-951-1560 FAX: 480-951-1601
e-mail: ercainc@aol.com

These tests must be monitored by recognized third parties capable of writing acceptable industry reports regarding the results of the 5 field tests over a period of 4 to 6 months.

The total cost of building the 6 tools and such a series of tests would be between 2.5 and 3 million dollars. When that is completed and the test results are published, the tool will market itself. ERICA is in need of a partner or partners to be able to accomplish these requirements.

A preliminary short term test of 5 to 7 days could be arranged at a cost of approximately $15,000 to $20,000 using the existing prototype tool to demonstrate to the potential partner or partners that the tool works.

ERICA THE COMPANY

The company was incorporated in the State of Nevada on September 9, 1986. The Company was originally formed to fund a California manufacturing company. The funding was raised by a public offering pursuant to an exemption provided by Rule 504 of Regulation (D) promulgated under the Securities Act of 1933 as amended. The name of the company was changed from WIMCO to ERICA by amendment to its Articles of Incorporation in accordance with the laws of the State of Nevada on September 8, 1992.

The address, telephone number, Facsimile number and e-mail address of ERICA is:

- 7349 Via Paseo Del Sur
- Scottsdale, AZ 85258

- 480-951-1560 Telephone
- 480-951-1601 Facsimile
- ercainc@aol.com e-mail

- The title, class and par value of the security : Common Stock, Par Value $0.001.
- Number of shares outstanding: 6,294,736
- Authorized Capital Stock: 25,000,000 shares of Common Stock.
- Dividends: No cash dividends have been paid to date.
- Stock Transfer Agent:: Holladay Stock Transfer, Phoenix, Arizona
- Current Officers & Directors: Leonard Manson, President and Chairman
  Barbara Manson, Secretary/Treasurer **Director**
  Leonard Manson II, Vice President Director

MANAGEMENT

New management would be required. Previous past officers have retired and in the case of Lincoln Brown have passed away. A young and aggressive group should take over the management of the company to deal with the marketing of the tool and to enhance the share value of the company.

Members of the previous management team are attached.

Management Team

The ERICA INTERNATIONAL management team combines both the technical knowledge and the practical experience needed to accomplish the company's goals..

The President, Lincoln Brown, brings to the company his management expertise, having served as President or CEO of several of the largest US companies, which operated globally. All officers and Directors have international backgrounds as well as technical education and experience.

CORPORATE OFFICERS AND DIRECTORS

Leonard L. Manson	Chairman of the Board
Lincoln Brown	President and Director
Leonard Manson II	Vice President and Director
Barbara London-Manson	Secretary-Treasurer and Director
John Critchfield	Director
Kirk DeShazo	Director
Gerrit Lemmen	Director
John Torongo	Director

LEONARD L. MANSON
CHAIRMAN, BOARD OF DIRCTORS

Mr. Manson has served as Chairman of the Board of ERICA since its inception in 1986. He is also the co-developer of the ERICA Oil Recovery Tool. Prior to this, Mr. Manson served as President of WIMCO, the Predecessor Company to ERICA.

Mr. Manson served as General Manager and Chief Engineer of Minera Leman S.A., in charge of exploration, exploitation and feasibility of the development of extensive mineral concessions located in Baja California, Sur, Mexico. He was the President of White Mineral resources and developed a large exploration project based on core drilling of the area.

Prior to this, Mr. Manson was President of Sweetwater Lake Development Company, which developed and engineered 3,500 acres of residential land, built two dams of 2000 feet in length, and 170 feet high, creating 550 acres of lakes. This community has 55 miles of roads, 3,200 residential lots, beaches, and all support facilities including sewer, water, electric and communication distribution systems.

Mr. Manson graduated from Illinois Institute of Technology with a degree in Civil Engineering.

LINCOLN BROWN
PRESIDENT

Mr. Brown has served as President and Director of ERICA since 1994.

From 1982 to 1994, Mr. Brown served as Chairman of the Board and CEO of INTELCOM GROUP COPORATION. Mr. Brown previously served for five years and the President of Kentron International, Inc., an LTV subsidiary. During his tenure at Kentron, corporate sales quadrupled in volume.

In 1968, Mr. Brown joined ITT as Vice President of Operations of Federal Electric Corporation. He later became President of ITT Arctic Services, Inc., and the in 1973, President of Federal Electric Corporation, with annual sales in excess of $300 million.

Mr. Brown served as Vice President and Senior Director of Northrop Page Communications, responsible for all company activities in the Pacific, including the engineering, furnishing and installation of the $200 million Integrated Wideband Communications System and its operation and maintenance. Mr. Brown worked for sixteen years for Melpar, Inc., where he progressed to management positions and subsequently became Vice President.

Mr. Brown graduated from the University of Florida, with the degree of Bachelor of Electrical Engineering. He continued graduate work at the University of Miami. He has served on the Advisory Board of the United Jersey Bank and on the Boards of several private companies.

LEONARD MANSON II
VICE PRESIDENT AND DIRECTOR

Mr. Manson has served as Vice President and a Director since 1994, has been involved with the development and field testing of the ERICA Oil Recovery Tool. In 1996, at the inception of the Water Purification and Bottling Division, Mr. Manson was transferred to the Russian project as Vice President of this Division.

From 1987 to 1994, he formed and operated Rico-Manson Export Company for the purpose of importing water purification equipment into Mexico. Mr. Manson also built and operated two water plants, AGUA PUREZA and AGUA CALAFIA in La Paz, Baja, California Sur, Mexico. Mr. Manson has been instrumental in the development and installation of several other water purification and bottling plants in the Americas. From 1984 to 1986, Mr. Manson was a Director of Interfinance America, Houston, Texas, a firm that provided commercial loans to hotels, motels, apartment complexes and large real estate development projects. Prior to 1984, he was a Director of United Penn Oil and Gas Company, Laredo, Texas, and supervised oil production, maintenance and the reworking of fields to increase production.

While attending the University of Houston, Mr. Manson II worked for Ozarka Water Company, Houston, Texas, and was responsible for establishing delivery routes, accounting and the sales of purified water to commercial and private customers.

Mr. Manson II also attended the University of Mexico, La Paz, Baja California Sur campus.

BARBARA LONDON-MANSON
SECRETARY TREASURER and DIRECTOR

Ms. London-Manson has served as Secretary /Treasurer and Director of ERICA since its inception in 1996. From 1984 to 1986, she was a Director of a tourist assistance agency in La Paz, Baja California Sur, Mexico.

From 1978 through 1984, she was a co-owner and operated a high fashion retail store in Brentwood California. Ms. London-Manson handled all financial aspects of this business until she relocated to Houston, Texas, when in 1984, she sold her interest in the store. While in Houston, Ms. London-Manson was Vice President of Interfinance America, as the senior loan officer.

During the period from 1969 through 1978, Ms. London-Manson was an Officer and Director of First Security Transfer & Trust Company in Phoenix, Arizona, responsible for all transfer of public stock for 102 customer companies. This organization was one of the first to become a computerized stock transfer company.

Prior to 1969, Ms. London-Manson was President of California Sunset, Inc., a California furniture manufacturer of high tech poly-resin outdoor furniture. She was the creator and designer of this furniture, which became the recipient of the Pasadena, California Design X Award for excellence in design and material. Her furniture was featured in major department and furniture stores throughout the United States, Canada and Latin America. In 1969, the company was sold to a NYSE manufacturer.

Ms. London-Manson received a Bachelor of Arts degree from the University of California at Los Angeles and has been a member of several Professional businesswomen's organizations.

JOHN CRITCHFIELD
DIRECTOR

Mr. Critchfield is Telecommunications Executive, with more than thirty-five years in the industry, serving in various managerial and technical positions in the aerospace communications, air transport communications, and international telecommunications networks, satellite communications systems and air traffic control systems.

His professional experience includes global voice and data network design and operations, the engineering and implementation of fiber and satellite systems in various international environments, European and Asian.

Mr. Critchfield served as Vice President and Director of the Bank of America's Systems Engineering Division, San Francisco Headquarters and Asia Division between 1976 and 1987. He then joined Intelcom Support Services, Dallas, Texas as Vice President, Marketing and Director of Operations. Subsequently, he managed his own Telecommunications Consulting Company and later joined the Societie International de Telecommunications Aeronautiques, a French company which operated the world's largest telecommunications network for its 600 air transport members and associated companies.

Prior to 1976, Mr. Critchfield served as a Program Manager with other Telecommunications companies including ITT-Federal Electric, Northrop-Page Communications Engineers, and Melpar in various projects in Asia and Europe.

Mr. Critchfield has a BA in International Finance from Ohio Wesleyan University, a BSEE degree from George Washington University and an MBA under the Harvard University program at Southeastern University. He also attended the Stanford Banking Institute, and has been an instructor at the University of Berlin (Germany) for Continuing Education, and the Asian Institute of Technology, Bangkok, Thailand.

GERRIT B. LEMMEN
DIRECTOR

Mr. Lemmen has served as a Director of ERICA since 1996.

From 1969 to 1989, Mr. Lemmen served as President and Chairman of the Board of E. H. Mauk and Sons, Inc., a nationwide supplier of wholesale forest products.

From 1983 to 1991, Mr. Lemmen had been President of Universal Commodities, Ltd.

Since 1990, Mr. Lemmen has been the President and Chairman of the Board of Tax Assistance Corporation, a national firm helping companies and individuals resolve existing IRS problems.

Mr. Lemmen graduated from Michigan State University with honors, receiving a Bachelor of Science degree and is a member of Sigma Lambda Chi honorary fraternity.

JACK R. TORONGO
DIRECTOR

Mr. Torongo is currently Executive Vice President of B.J. Development Group, Basin Enterprise and Canyon Minerals. In this capacity, he has managed all financial and internal affairs of these companies. In addition, he has drilled and completed hundreds of gas and

oil wells in Ohio, Pennsylvania and West Virginia, and supervised the production of all these wells.

Mr. Torongo has been Vice President of Marketing for Briggs Manufacturing Company, Detroit, Michigan, and supervised all Regional Managers, Salesmen and produced annual sales volumes in excess of 120 million dollars.

Early in his career, Mr. Torongo was Regional Sales Manager for Rheem and Roud Manufacturing Company, Chicago, and produced annual sales in excess of 10 million dollars.

He served in the US Army Air Force, piloting single and multi-engine planes, and later served as a flight instructor. He holds a commercial pilot rating in both single and multi-engine aircraft.

Mr. Torongo attended the University of Detroit, Gettysburg College, Michigan State and the University of Michigan.

KIRK D. DESHAZO
DIRECTOR

Mr. DeShazo is co-owner of the DeShazo Production Company, an independent oil and gas production company managing fields in Oklahoma. Mr. DeShazo is assisting ERICA with its research and development of the oil recovery tool.

Mr. DeShazo has been President and CEO of Boulevard Pharmacy, Inc., Bartlesville, Oklahoma, since 1965, which established Bartlesville's first discount pharmacy. In 1983, Mr. DeShazo expanded this business to include Boulevard Homecare Center, to encompass medical equipment and supplies, the area's largest volume independent pharmacy and supply company.

Between 1963 and 1965, Mr. DeShazo was co-owner of Rexall Drugs in Dewey, Oklahoma, a family owned pharmacy which was established in 1932.

Mr. DeShazo graduated from Oklahoma University School of Pharmacy in 1960, and commenced his career as Operations Manager for Veazey Drug Company, in Oklahoma City.

BUSINESS DESCRIPTION

MARKET OVERVIEW

PROJECTIONS

OIL TECHNOLOGY DIVISION

BUSINESS DESCRIPTION

ERICA Oil Recovery Tool - ERICA is the developer and owner of an Oil Recovery tool, which has been tested and proven effective in providing increases in the quantity and quality of oil from existing oil fields in the United States. This tool is the result of years of experimentation and testing involving field and laboratory testing to validate the theory, identification of materials with suitable properties, construction and experimentation with design and component configurations and the design and construction of a working tool for use in standard oil fields. In addition to the oil production enhancement application, which has been tested and proven, other uses of the technology, including oil pipeline flow enhancement (this application is included in the patent pending) and oil refining, are being developed and tested.

Over the past seven years, ERICA has been researching and testing the effects of "Pulse Power", or "high voltage shock" on the hydrocarbon molecules of crude oil. A patent on the tool and applications for the tool have been filed and are currently pending The results of the testing both in the field and in the laboratory have shown a dramatic increase in the production of crude oil from stripper wells. It has been now proven that the "cracking" of the hydrocarbon molecules releases otherwise "sleeping" gas and gives the wells new energy to produce increased crude oil. Most stripper wells decline in production when the energy drive decreases to the point that other expensive methods of increasing production must be used, such as water floods, injection of chemicals, etc. In most cases, these other types of artificial production increases are not economically feasible. The ERICA down-hole electronic tool can be placed in the center of a field either in a stripper well or in an injection well. The high voltage shock can be pulsed continually to re-energize the surrounding wells. ERICA has produced seven generations of this tool and now has a reliable production model ready for manufacture for commercial use as a rented unit to oil operators.

The ERICA Oil Recovery Tool (42 feet long) is lowered into the casing of an existing injection well or existing oil well in the center of a field and is operated from the system's control center located at the surface. Operation is automatically controlled by the system after initial set up. One oil tool will treat the affected oil wells in approximately ¼ section of land in an oil field. The tool is presently designed to operate in wells with a maximum depth of 8,000 feet.

The tool will be monitored and maintained on a daily basis by a fully trained oil service company approved by ERICA. The Oil Recovery Tool will be owned by

ERICA and available for rent on a month-to-month basis through an approved oil service company. Each tool will rent for $5,000 per month paid in advance. A security deposit of $5,000 will be collected with the first month's rent along with any applicable duties, taxes, etc. The renter will also pay for cable and installation charges. The oil service company will retain $1,000 of each month's rent for its services.

The ERICA Oil Recovery Tool produces immediate results is economical to operate and environmentally safe. Field tests have demonstrated that one tool which produces a daily increase in oil production of 20 barrels should increase an operator's monthly gross income by approximately $18,000 based on an approximate current oil price of $30.00 per barrel. This would make it economically feasible for the small operator to produce his oil thus increasing the production of oil in the United States and decreasing dependence on imported oil.

MARKET OVERVIEW

(SEE ATTACHED)

MARKET OVERVIEW

ERICA Oil Recovery Tool - There are currently over 500,000 stripper oil wells in the United States for which the ERICA Oil Recovery Tool has an application.

Based on Department of Energy reports, these wells contain over 350 billion barrels of oil reserves, most of which will be left in the ground without some sort of outside stimulation. Less than 1/3 of the total reserves have been produced to date. Thousands of wells that have been considered not economical to produce have been plugged, losing the recoverable reserves forever. The stripper well industry produces 14% of the United States oil consumption, employs between 60,000 to 80,000 people, and is an integral part of the economy in the 29 oil producing states in the United States. The United States imports over 60% of our oil at a cost of over 1 billion USD per week. This accounts for over a 52 billion-dollar trade deficit per year .

Secondary recovery systems currently in use are in general too expensive for most independent oil operators, and the increase in production is nominal. Most of these secondary recovery systems consist of injecting water, steam, gas, etc. into the producing oil zones which, in some instances hinder the production rather than increase production due to chemical changes in the fluids and the oil formation.

The ERICA Oil Recovery Tool gives immediate results, is economical to operate and environmentally safe. It does not affect the chemistry of the oil formation since the system is based on pure energy using the oil in the zone to revitalize the field.

The entire oil industry is in need of this new technology to extract the oil reserves now being left behind.

Since there does not exist any similar technology in the market at this time, the company feels it can rent the ERICA Oil Recovery Tools as fast as it can produce them and train local oil service companies to operate them.

Field test experience has also shown that the ERICA Oil Recovery Tool affects over ¼ section of land. A field having 8 to 10 wells producing 2 ½ barrels of oil per each well will produce 20 to 25 barrels of production per day. Calculating that increase of 20 barrels per day @ $16 per barrel, the operator would then increase his monthly revenue $9,600 per month.

Based on the above formulae, the company anticipates renting the tool for $5,000 per month to the operator.

The company's actual experience in field-testing has shown an increase in oil production in excess of 100% and a maximum of 300%. In addition, the oil to water ratio has been improved, which in turn, lowers lifting (operating) cost.

Technologies to Solutions

DID YOU KNOW that over on-half of the United States oil was imported at a direct cost of about $1 billion/week in 1996; yet, only one-third of the discovered original oil in place in the U.S. has been recovered?[1]

DID YOU KNOW that the Interstate Oil and Gas Compact, Commission (IOGCC) which represents the governors of 29 oil and gas producing states points out that marginal wells (Stripper Wells) account form ore than $10 billion in U.S. Economic activity, more than 60,000 jobs nationwide are dependent on a healthy marginal well industry and just under 14% of the oil production in the U.S. Christine Hansen, IOGCC Director is quoted "Right now, the U.S. is putting American lives on the line and spending untold millions on military actions in the Middle East to protect oil supplies and shipping lanes. We believe that equal emphasis should be placed on ensuring our own resources are not lost to the economic war faced by producers of marginal oil."[2]

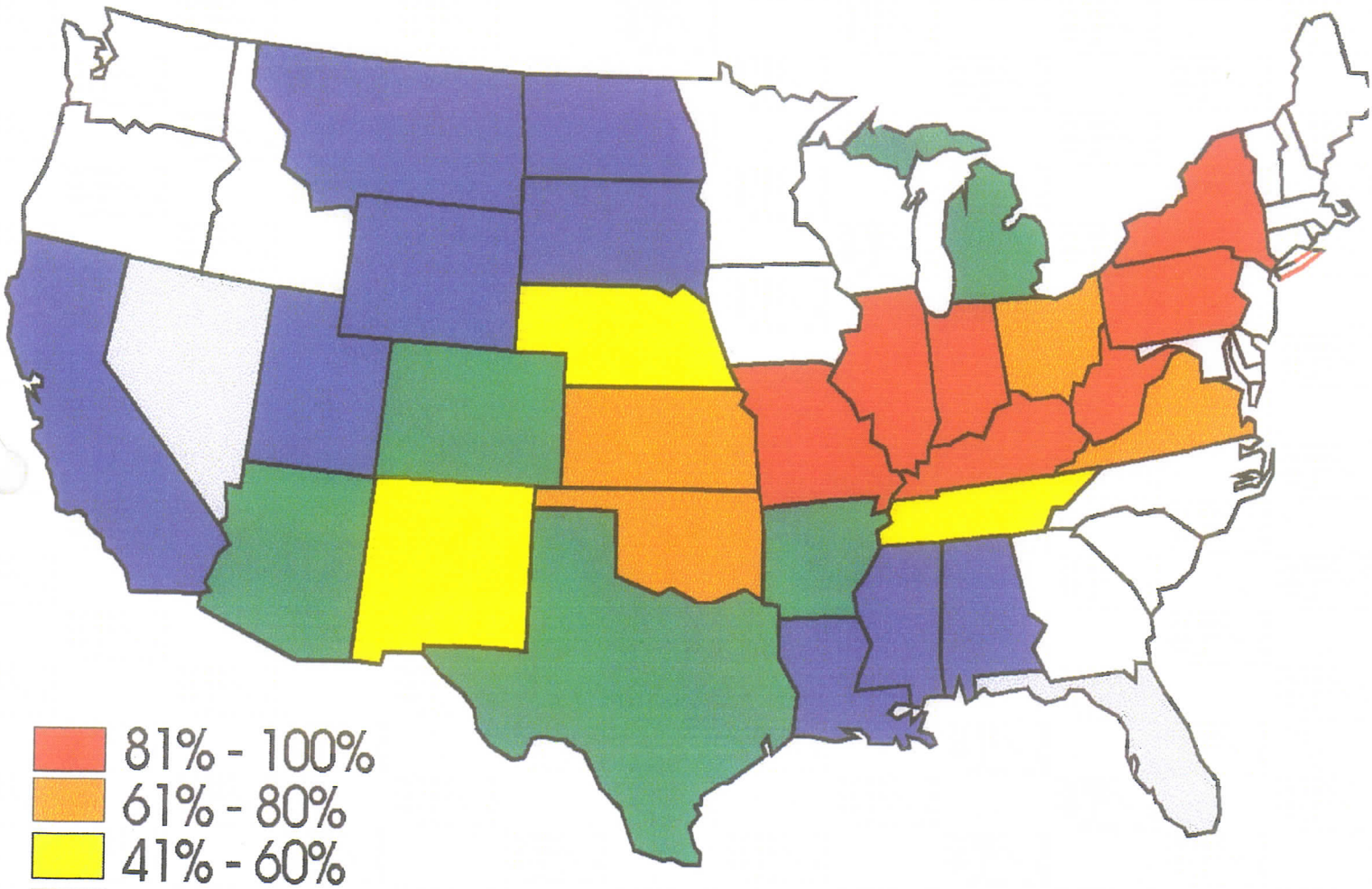
Over the past four years, ERICA has been researching the effect of specific technology on hydro-carbon crude oils. The results of these tests have been dramatic. ERICA has put its engineering efforts into affecting the existing crude oil rather than affecting the oil zones as is the usual method of increasing production in marginal wells.

The ERICA Oil Recovery Tool as shown on the cover of the brochure has been built to re-energize the oil field. The targets of this energy are the hydro-carbon's, not the sand, shales and limestone oil zones. The concept is to improve the oil to water ratio, increase the bottom hole pressure, and reduce the viscosity of the oil to improve the flow of oil. The resulting increase in production of the marginal wells utilizing the ERICA Oil Recovery tool is more immediate than other methods that require 6 to 9 months to show effective results. Results from the operation of the tool are manifested within days, and field testing has shown the average increase in production has been approximately 200% to 300% increase per day in oil production.

The ERICA Oil Recovery Tool is now ready for production and marketing to the industry. The company is researching various funding methods for this production.

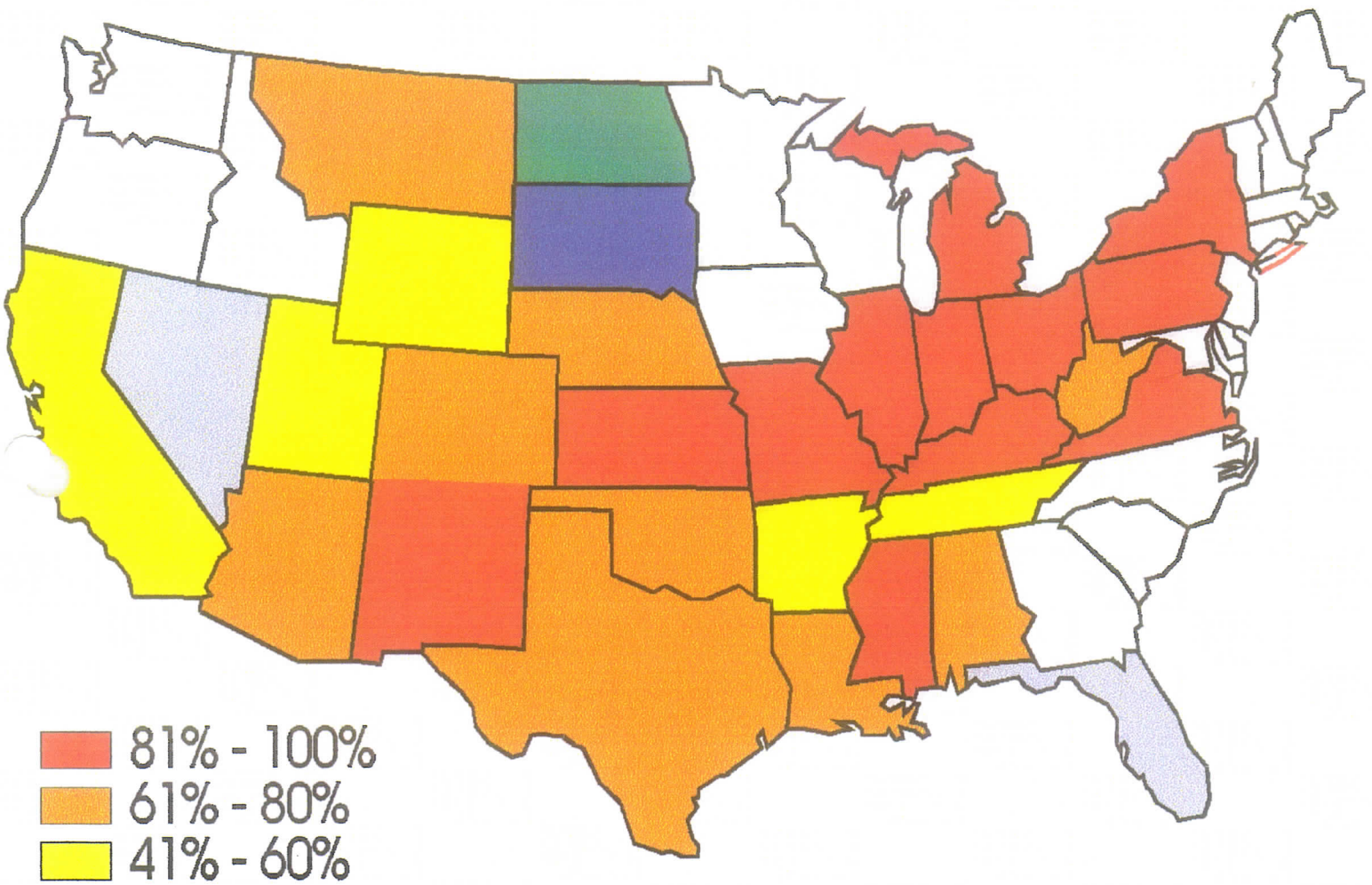
[1] Department of Energy reprint from SBIR grant application for March, 1997.
[2] Marginal Oil and Gas: Fuel for Economics Growth/IOGCC. Reprints (405) 525-3556, ext. 101.

Crude Oil Stripper Wells Production as a Percentage of Total Crude Oil Production



81% - 100%
61% - 80%
41% - 60%
21% - 40
0% - 20%
No Data Available

Crude Oil Stripper Wells as a Percentage of all Crude Oil Wells



81% - 100%
61% - 80%
41% - 60%
21% - 40
0% - 20%
No Data Available

BUSINESS REPORT UPDATE

MARCH 1996

ELECTRONIC OIL RECOVERY TOOL, AND OIL PRODUCTION

ERICA, a Nevada Corporation, headquartered in Scottsdale, Arizona, with offices in Dallas, Texas, and Nowata, Oklahoma, is currently trading on the NASDAQ Bulletin Board under the symbol "ERCA." The company was incorporated in 1986, and was re-activated three years ago, and reinstated for trading in October of 1994.

The re-activation of ERICA, was instituted primarily for the purpose of researching the possibility of using "PULSE TECHNOLOGY" for the development of a down hole Electronic Oil Recovery Tool to increase oil production in oil fields that are currently producing, but have declining production, and are in the need of a secondary recovery method at a moderate cost to the producer. More detailed information on ERICA's proprietary Electronic Oil Recovery Tool appears in another section of this report.

During the last three years, ERICA has been engaged in research, development, and testing of the Oil Recovery Tool. The Company and it's Engineers have been researching the required components, and the ranges of energy necessary to determine the maximum increase in production possible using the ERICA Electronic Oil Recovery Tool, and the method of PULSE TECHNOLOGY. The Company now has a production model Oil Recovery Tool, and the Patent Applications were filed on July 26, 1995.

The Company is continuing to monitor the performance of the Tool in Northeast Oklahoma in several oil fields. Based on the positive results of the production model of the Oil Recovery Tool, ERICA is now taking the first steps necessary to develop the capital required to begin production and marketing of the ERICA ELECTRONIC OIL RECOVERY TOOL on a large scale.

The first step that the Company will take is to become a fully reporting company by filing a Form 10 with the Securities and Exchange Commission. This should enable ERICA to enjoy a wider range of securities brokerage firms to trade the shares of ERICA. After this filing is complete, the second step will be to initiate a Secondary Public Offering of the shares of ERICA to raise approximately $5,000,000. necessary for the production and marketing of ERICa's proprietary ELECTRONIC OIL RECOVERY TOOL.

The Company has maintained a financially solvent position throughout this time of research, testing and development of the production model of the ERICA ELECTRONIC OIL RECOVERY TOOL, and the Patent Filing, through investment and loans of monies, primarily from the Officers and Directors.

RESEARCH-- OVERVIEW OF THE ERICA ELECTRONIC OIL RECOVERY TOOL

There are substantial amounts of proven data regarding the United States domestic oil reservoirs. To date, these oil reservoirs have produced in excess of ten billion barrels of oil. The estimated remaining reserves is approximately 150 billion barrels of oil, which includes reserves contained in both producing and non-producing fields.

However, recovery of these reserves has, in most cases, not been feasible due to the high costs of conventional recovery methods. Until the development of the ERICA Oil Recovery Unit, the traditional methods of oil recovery enhancement have been either water injection or secondary waterflood systems, both of which are impeded by the viscosity of heavy crude oil reservoirs. Waterflood can close the pore channels, and trap the oil. In shallow wells, steam as been utilized with limited success. These traditional methods require time, capital, and disposition of waste water, which could pose an environmental hazard.

The solution to the foregoing problems is to economically remove oil from the deposit by separating and extricating the pockets of crude oil from their pore spaces, thereby freeing the flow to the well head in an environmentally safe process. The process involves the application of pulse energy which alters the fluid distribution in the formation, and changes the characteristics of the flow, thereby enhancing the oil recovery.

The ERICA Electronic Oil Recovery Tool provides a solution to the problems by setting up a detectable shock wave to produce immediate results in the flow characteristics, and resultant reservoir pressure allowable. The shock wave breaks the heavy oil molecule, thus creating thinner fluids, and a natural gas drive. The thinner fluid, with this new natural gas drive flows more easily to the producing wells without the introduction of foreign materials to the zone which would negatively affect the flow of oil by clogging.

The advantages provided by the ERICA Oil Recovery Tool are: (1) there is no need for handling high volumes of water as in a water recovery system; (2) the tool can be organized and installed rather quickly; and (3) the improved flow results can be expected in a matter of days, not weeks or months as with conventional systems.

The ERICA Electronic Oil Recovery Tool has proven successful through utilization of a capacitance discharge of several thousand volts, which produces a multiple in the amount of Joules in a controlled shock wave created by the discharge of this energy across a spark gap, with repetitive and continuous capability to sustain the fluid recovery.

INCOME PROJECTIONS - OIL RECOVERY TOOL

	Year 2011	Year 2012	Year 2013	Year 2014	Year 2015
Number of units	100	200	300	400	500
Rental Inome Monthly	1,500,000	3,000.00	4,500,000	7,500,000	9,000,000
Rental Income Annually	18,000,000	36,000,000	54,000,000	72,000,000	90,000,000
Less Equipment Cost	5,000,000	5,000,000	10,000,000	10,000,000	10,000,000
Gross Income	**13,000,000**	**31,000,000**	**44,000,000**	**62,000,000**	**80,000,000**
Operating Expenses					
Advertising	48,000	48,000	48,000	50,000	50,000
Entertainment & Promotion	100,000	100,000	100,000	100,000	100,000
Travel	150,000	150,000	150,000	150,000	150,000
Depreciation	2,500,000	5,000,000	7,500,000	7,500,000	7,500,000
Maintenance Repair	1,000,000	2,000,000	3,000,000	4,000,000	5,000,000
Insurance	100,000	200,000	300,000	400,000	500,000
Office Expense	50,000	50,000	100,000	100,000	100,000
Commissions	100,000	100,000	100,000	100,000	100,000
Operators & Labor	1,000,000	2,000,000	3,000,000	4,000,000	5,000,000
Legal	100,000	100,000	100,000	100,000	100,000
Miscellaneous	200,000	200,000	200,000	200,000	200,000
TOTAL EXPENSES	**5,348,000**	**9,948,000**	**14,598,000**	**16,650,000**	**18,750,000**
ADJUSTED GROSS INCOME	**7,652,000**	**21,052,000**	**29,402,000**	**45,350,000**	**61,250,000**

Notes:
Cost Per Unit: 50,000
Depreciation: 2 years
Rental Income Per Unit: 15,000 per month

INDEPENDENT LABORATORIES

TEST REPORTS

Texaco Terminals Inc
Central Region Lab

P O Box 711
Cushing OK 74023
918 225 1454

The preceding analysis are boiling range distributions or High Temperature Simulated Distillations. They were performed on a Hewlett Packard 5890 Series II gas chromatograph using a HP 7673 GC/SFC Injector. The column type was a 5m, 0.53 mm ID, 0.09u Methylsilicone, Alu clad with a AC PTV injector. Data analysis was by HP ChemStation and Analytical Controls software. The calibration consisted of two CS_2 blanks, a calibration mixture of *n*-paraffinic hydrocarbons including *n*-C_5 to *n*-C_{130}, and a reference oil mixture.

The boiling range distributions of petroleum gives insight into the composition of the oil and products relating to the refining processes. Simulated distillation based on gas chromatography allows for quick and accurate comparison of petroleum oils and their components.

Texaco Terminals Inc
Central Region Lab

P O Box 711
Cushing OK 74023
918 225 1454

ERICA
7349 Via Paseo Del Sur, Suite 525-331
Scottsdale, AZ 85258
Attn: John Critchfield

Feb. 20, 1996
Report # 9718

Subject: Petroleum Analysis
Lab ID#: 14002-14005
Date submitted: 02/15/96
Sample ID: Listed below

Sample ID	Parameter
Osage Crude Before Treatment	Sim-Dist

IBP	<97°F	25%	203°F	50%	462°F	75%	757°F
1%	99	26	208	51	475	76	770
2	112	27	210	52	486	77	783
3	117	28	212	53	495	78	795
4	123	29	214	54	507	79	810
5	125	30	216	55	518	80	824
6	127	31	221	56	527	81	840
7	158	32	230	57	540	82	856
8	167	33	239	58	552	83	871
9	169	34	253	59	563	84	887
10	171	35	264	60	576	85	903
11	172	36	270	61	583	86	921
12	174	37	280	62	595	87	937
13	176	38	293	63	606	88	957
14	178	39	306	64	617	89	977
15	180	40	313	65	630	90	999
16	181	41	324	66	642	91	1022
17	183	42	340	67	655	92	1047
18	187	43	349	68	667	93	1074
19	189	44	360	69	678	94	1099
20	190	45	374	70	693	95	1130
21	192	46	397	71	705	96	1162
22	194	47	421	72	718	97	1200
23	196	48	437	73	730	98	1245
24	199	49	455	74	743	99	1310

Texaco Terminals Inc
Central Region Lab

P O Box 711
Cushing OK 74023
918 225 1454

Sample ID — **Parameter**

Osage Crude After 400 Shots — Sim-Dist

IBP	<97°F	25%	208°F	50%	473°F	75%	761°F
1%	<97	26	210	51	486	76	775
2	<97	27	212	52	495	77	788
3	<97	28	214	53	505	78	801
4	97	29	219	54	516	79	815
5	138	30	225	55	525	80	831
6	162	31	234	56	538	81	847
7	167	32	246	57	550	82	862
8	169	33	259	58	559	83	878
9	172	34	266	59	570	84	894
10	174	35	275	60	581	85	910
11	176	36	284	61	590	86	927
12	178	37	297	62	603	87	943
13	180	38	307	63	612	88	961
14	181	39	315	64	624	89	981
15	183	40	327	65	635	90	1002
16	185	41	343	66	648	91	1024
17	187	42	351	67	658	92	1049
18	189	43	361	68	673	93	1076
19	190	44	376	69	684	94	1101
20	192	45	397	70	696	95	1132
21	194	46	423	71	709	96	1166
22	198	47	437	72	721	97	1202
23	201	48	455	73	736	98	1249
24	207	49	462	74	748	99	1312

RIVERSIDE LABORATORIES

2840 Charles Page Blvd.
Tulsa, Oklahoma 74127
(918) 585-3064

19February97

Leonard L. Manson
ERICA
Suite 515-331
Scottsdale, Arizona 85258

The following is in response to your request for an explanation of the tests and results for the oil samples received 06February97. ASTM method D445 was used to determine the viscosity in centistokes (cSt) at 100° centigrade (212°F). The procedure is an internationally accepted method of measuring viscosity (resistance to flow) in exact units of measure (centistokes) at a given temperature (usually 40°C or 100°C).

Generally, as an oil's viscosity decreases the oil becomes lighter. For point of reference, #2 diesel fuel is approximately 1.14 cSt @ 100°C. A 10W-30 motor oil is approximately 10.5 cSt @ 100°C.

The test results obtained on the above samples show that after the initial 25 shot treatment, the oil significantly decreased in viscosity indicating the oil became lighter.

Please contact me if you need further information.

John R. Cramer, Jr.
Laboratory Manager

RIVERSIDE LABORATORIES
2840 Charles Page Blvd.
Tulsa, Oklahoma 74127
(918) 585-3064

06February97

Leonard L. Manson
ERICA
7349 Via Paseo Del Sur
Suite 515-331
Scottsdale, Arizona 85258

The following ASTM D445, viscosity @ 100°C, results were obtained for the eight oil samples received 06February97.

Lab#/Sample	Results, cSt
25085 Pit oil	NDA*
25086 Pit oil, 25 shots	7.41
25087 Pit oil, 50 shots	4.54
25088 Pit oil, 96 shots	4.12

*Repeated attempts to test 25085 were unsuccessful due to excessive foaming.

25092 Spade crude	2.68
25091 Spade crude, 100 shots	2.39
25090 Spade crude, 200 shots	2.74
25089 Spade crude, 300 shots	3.05

Some of the samples contained a large amount of grit. The Pit oil samples also foamed considerably. To avoid these problems in future samples, I suggest we use the ASTM D88, Saybolt viscosity at 100°F (40°C). The results are measured in SSU seconds which can be recalculated to centistokes (cSt). I have ordered oil screen filters to eliminate sample debris.

Please contact me if you have any questions.

John R. Cramer, Jr.
Laboratory Manager

RIVERSIDE LABORATORIES
2840 Charles Page Blvd.
Tulsa, Oklahoma 74127
(918) 585-3064

25February97

Leonard L. Manson
ERICA
Suite 515-331
Scottsdale, Arizona 85258

The following results were obtained for the oil samples received 25February97.

Sample	Lab #	Gap	Shots	Kv	Viscosity @ 100°C, cSt	Date
Osage #0	25293	N/A	N/A	N/A	2.30	NDA
Osage #1	25292	NDA	25	8.3	1.99	02-22-97
Osage #2	25291	NDA	50	NDA	2.10	02-22-97
Osage #3	25290	NDA	75	9.0	2.39	02-22-97
Osage #4	25297	3/32	100	8.5	1.50	02-22-97
Osage #5	25296	NDA	175	9.5	1.52	02-22-97
Osage #6	25295	NDA	225	8.0	1.70	02-23-97
Osage #7	25294	1/16	275	8.0	1.73	02-23-97
Osage #8	25299	NDA	325	8.0	1.31	02-24-97
Osage #9	25298	NDA	400	8.0	3.89	02-24-97

Please contact me if you have any questions.

John R. Cramer, Jr.
Laboratory Manager

FIELD TEST REPORTS

&

FIELD OWNERS OBSERVATIONS

CONFIDENTIAL REPORT

TEST OF OIL STIMULATION RECOVERY TOOL
BUSHFIELD LEASE & MARY ROSS LEASE
NOWATA, OKLAHOMA
FEBRUARY 1st THROUGH FEBRUARY 7th, 1995

FEBRUARY 1, 1995

OBSERVERS: L. Manson, L. Manson Jr., Robert Redding E.E.

1. Arrived at site for testing @ 8:30 A.M.

2. We Observed well that had been cleaned prior to installation of Stimulation Tool. Thirty feet of broken shale material had been removed, and the well had been loggedby Well Logging, Inc., Nowata, OK. in order to locate exact depth of oil zone.

3. Test site has 2 other operating wells, plus the well in which the Oil Stimulation Tool was to be installed. For this report, those wells will be referred to as Well # 1, and Well #2.

4. Well # 1 is located 320 Ft. West of the Stimulation well. Well # 2 is located 1,320 Ft. North of the Stimulation Well. All wells are open hole completion.

5. 10:30 A.M., Prior to Stimulation. Activated pumps on both Well # 1, and Well # 2.

6. Well # 1, pumped for 50 minutes, produced 98% salt water, with streaks of oil and ran dry.

7. Well # 2, pumped 30 minutes, what appeared to be mostly oil, and ran dry.

8. Both wells together, pumped a total production for the day of 1/2 Barrel of oil. This has been the production of the two wells for about 15 years, based on pumper and producer reports.

FEBRUARY 2, 1995

OBSERVERS: L. Manson, L. Manson Jr., Robert E. Redding E.E.

1. Returned to site at 4:30 P.M. to verify amount of oil pumped that day from Wells # 1 and # 2.

2. Wells # 1 and # 2, pumped 1/2 Barrel of oil, total.

FEBRUARY 3, 1995

OBSERVERS: L. Manson, L. Manson Jr., Robert E. Redding E.E., Jerry Fox, Andrew Fox.

1. Brought Stimulation Tool to site.

2. Pumped Well # 1 and # 2 down. Both wells produced 1/2 Barrel of oil in total.

3. Rig arrived at 12:00 Noon, and set up to install Stimulation Tool.

4. Installation of tool completed at 5:30 P.M. No wells pumping.

5. 5:45 P.M. Control panel of tool was set to fire the tool at 1/2 of the capacity of the tool, and was then set on automatic to fire every 1.25 minutes.

6. With tool firing on automatic, the observers left site.

FEBRUARY 4, 1995

OBSERVERS: L. Manson, L. Manson Jr., Robert E. Redding E.E., Jerry Fox, Andrew Fox.

1. All parties arrived at site at 8:00 A.M. and observed that Stimulation Tool was not firing.

2. Robert Redding noted that a fuse had blown.

3. Control panel indicated that tool had fired 120 times, prior to fuse problem. Based on firing sequence of 1 fire each 1.25 minutes, the tool had fired for 2 hours and 10 minutes.

4. 9:45 A.M. Measured oil storage tank level. Level was noted to be 5 feet and 10 inches. Oil Storage Tank services both bells. It should be noted that 1 inch equals 1 barrel of oil in storage tank.

5. Began to pump Well # 1 at 10:00 A.M.
Began to pump Well # 2 at 10:30 A.M.

10:30 A.M. through 5:30 P.M.
All Observers Present

6. Well # 1 pumped 4 hours. (Observed on February 1,2,and 3, to have pumped 50 minutes each day)

7. First 2 hours, Well # 1 pumped mostly water, with oil streaks.

FEBRUARY 4, 1995, Continued

8. Second 2 hours, Well # 1, pumped what appeared to be pure oil, in conjunction with a large amount of gas.

9. Well # 2, was turned on at 10:30 A.M.

10. Well # 2 began to pump pure oil with no visible show of water, and contained large amounts of gas.

11. At 5:30 P.M., Well # 2 was still pumping.

12. 5:45 P.M. All observers left site, Well # 2 still pumping.

FEBRUARY 5, 1995

OBSERVERS: L. Manson, L. Manson Jr., Robert E. Redding E.E. Jerry Fox, Andrew Fox. All arrived at 9:00 A.M.

1, Well # 2 had ceased to pump.

2. All observers measured oil storage tank.

3. Storage tank measured 6 feet, 5 inches of oil. Based on 1 inch per barrel, and a beginning measurement of 5 feet, 10 inches in the storage tank, both wells togehter had produced 7 barrels of oil in a 24 hour period. (Note: Tool had only fired a total of 2 hours and 10 minutes.)

4. 10:00 A.M. Pulled tool from Stimulation Well, to locate problem with firing mechanism.

5. Located slow leak in the lower union of tool. Leak allowed salt water to enter tool, causing short, extensive damage, and salt water contamination to tool.

6. Observed Wells # 1 and # 2. Both wells had declined back to pumping a total of 1/2 Barrel of Oil per day, together.

FEBRUARY 6th & 7th, 1995

OBSERVERS: L. Manson, L. Manson Jr., Robert E. Redding E.E.

1. Arrived at site at 3:30 each day.

2. Observed Wells # 1 and # 2. Both still pumping only 1/2 Barrel of Oil of total oil per day.

CONCLUSIONS

1. The oil produced by Stimulation of the Tool, contained large amounts of gas. Gas shows not seen in the oil zone known as the Bartlesville sand in this area for many years.

2. Oil to water ratio greatly improved. Exact ratio not known.

3. Percentage of increase of production very substantial. Based on short firing time of the Tool of 2 hours and 10 minutes, the increase could be calculated at 14 times original production of 1/2 Barrel per day, or 7 Barrels of oil in a 24 hour period.

Jerry Fox
3700 Dana Drive
Bartlesville, OK 74006-6603
PH 918-333-7915

Lennie,

Thank you for the opportunity to be involved in the developement of the tool. Let me say first how impressed I was when I began seeing the results. I personally ran the tool in one of my wells on the Bushfield lease near Winganon, Oklahoma. To be frank with you I was very skeptical that this tool would work. I had two test wells in the pattern which pumped fluid (oil & water) for 40 and 45 minutes respectively. When you hooked up the tool to the electric box and began operations, I oberved something that astonished me. Within the hour I observed an increase in gas from the formation. The well that had pumped off in 40 minutes the day before, now took 7 1/2 hours. The well that was pumping 45 minutes, now took 9 hours to pump off. We also observed a 6 1/2 barrels of oil per day increase.

With 45 years experience in the oil business, I have never experience such dramatic production stimulation. Because of this, I am requesting four (4) units to be delivered to my company, to be installed on my other leases in and around Nowata, Oklahoma.

My respects to you and your crew for a great accomplishement.

Sincerely,

Jerry Fox

Lennie,

On March 12,1996 - ran tool - set at 1,222 Ft.; Set Time - 3 Hours

March 13,1996 we fired 236 shots at 40 second intervals at 9 kv time for 6 hours. Lease made 3 barrels.

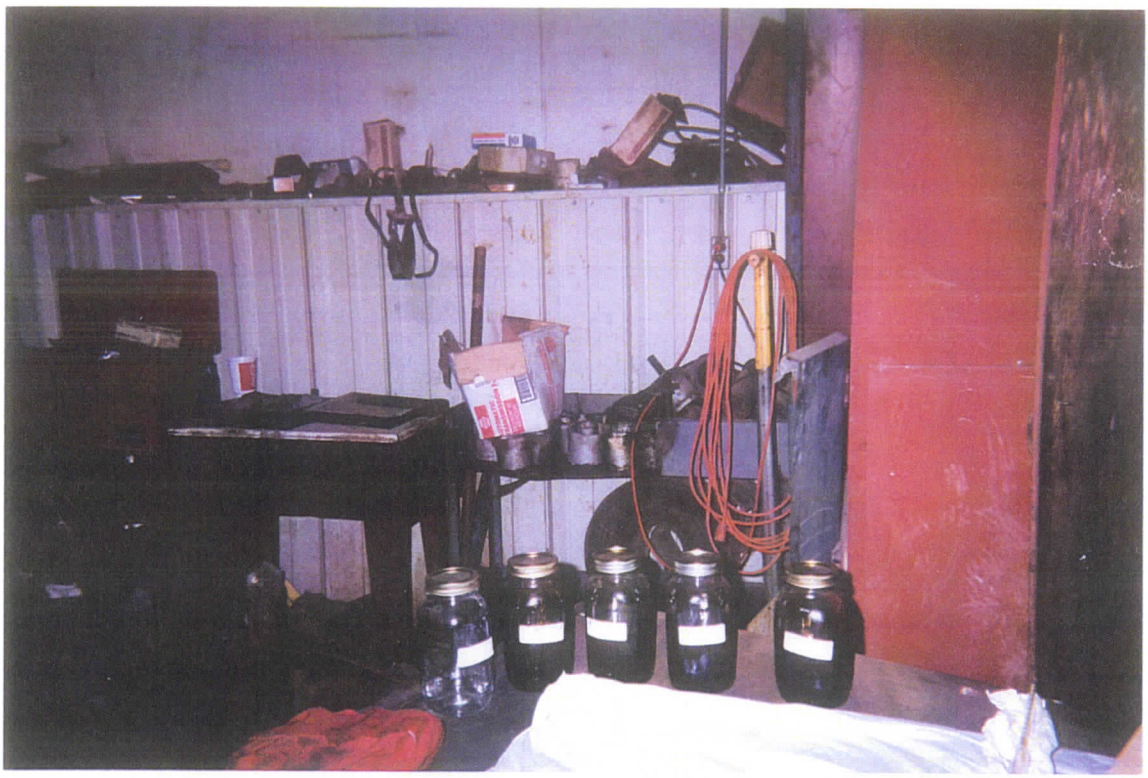
On Thursday, March 14, 1996, we changed time - 6 hours on and 6 hours off. Fired 672 shots. Made 6-1/2 barrels.

On Friday, March 15, 1996 - blown fuse, tool shorted out, pull[illegible] took to Nowata. Lease made 10-1/2 barrels.

All guaging occurred at 1:22 P.M. every day.

Don
Fax No. 1-918-534-1826

CIRCULATION TEST UNIT TO TEST VISCOSITY



CRUDE OIL SAMPLES WITH NUMBER OF SHOTS TO BE TESTED FOR VISCOSITY

THIS WELL WAS NOT PRODUCING AND ONLY HAD A VALVE, NO PUMP JACK. THIS WELL WAS 1,320 FEET FROM THE OSAGE TEST WELL. NOTICE THE GASOUS OIL FLOWING WHEN THE VALVE WAS OPENED.

TWO DRUMS OF OIL WERE FILLED FROM THE ABOVE NON-PRODUCING WELL IN OSAGE COUNTY.

FIRST TEST, ROGERS COUNTY, OKLAHOMA
WELL WENT FROM ½ BBL PER DAY TO 6 BBL PER DAY
(NOTICE THE GAS)

INTSALLING THE TOOL IN OSAGE COUNTY, OKLAHOMA

PRELIMINARY ENGINEERING REPORT

BY

ANTHONY LANE, PE & GEOLOGIST

PRELIMINARY REPORT
ERICA SECONDARY OIL RECOVERY TOOL TEST
OSAGE COUNTY, OKLAHOMA
OCTOBER 29, 1996

TABLE OF CONTENTS

ANTHONY LANE
P.E. & GEOL.

P.O. BOX 5843
TUCSON, ARIZONA
602-888-5248

PRELIMINARY REPORT
ERICA SECONDARY OIL RECOVERY TOOL TEST
OSAGE COUNTY, OKLAHOMA
OCTOBER 30, 1996

INTRODUCTION

The ERICA secondary oil recovery system was developed by Robert Redding and Leonard Manson of ERICA in 1992.

The system and application was adapted from prior applications including demolition and metallurgical applications.

Subsequently, the tool was developed and field tested in North Eastern Oklahoma, in and around Nowata, Oklahoma. The area was selected for a multiple of reasons including (1) local interest and suport, (2) shallow production (3) developed fields normally scheduled for capping by state law.

This early testing sequence, although results were positive, were non-conclusive due to mechanical and electrical problems with the tool, resulting in erratic testing periods. This did not allow analysis of the cumulative effects of the tool.

In 1996, ERICA elected to contract with Maxwell Federal, and Maxwell Technologies to redesign portions of the tool, and construct the tool in its entirety.

THE SYSTEM AND APPLICATION

The system consists of timed high voltage input to oil zones which result in (A) hydraulic movement and (B) chemical change in the hydro-carbon valence.

Subject to the permeability of the attacked zone, penetration can extend laterally throughout the zone, repressuring the producing zone, and increasing recoverable reserves.

THE TEST

The tool was transported from the Maxwell facility in California to Oklahoma October 9th, 10th, and 11th, 1996 in a semi-assembled condition. The tool was assembled in Nowata, Oklahoma at Total Services, Inc., by a Maxwell Technologies engineer on October 12th, and 13th, 1996.

The site selected for the test was the DeShazo-Slaveun-Elkins

Lease. This lease, which consists of three adjoining 160 acre tracts, which lie in Sections 15 and 16 Township 24 North, Range 11 East.

The lease is reached by following State Highway 123, South from Bartlesville, Oklahoma, to Barnsdall, Oklahoma, thence East on State Highway 11 to Counth Rd. 2331, thence North to the Lease which is identified by a sign. Of the total of the wells in this lease, 29 are cased wells. The test was conducted on 14 wells producing in the Peru zone. The lease is being produced predominantly from the Peru section, which is a shale-sandstone of the Paleozoic Era, lying in the middle Pennsylvanian series. Other producing sections below the Peru include the Oswego Limestone and the Bartlesville sandstone, to which some of the wells are producing and completed.

The well selected for the test is the Elkins No. 27, which had been partially tested with the ERICA recovery tool in March 1996, for a total period of 12.5 hours, resulting in some increase in bottom hole pressure (reported) with a reported increase of 5 plus barrels. The test well selected for this current test is centrally located in the area of the producing well in the lease.

The tool was lowered in the selected well, the Elkins No. 27 on October 14th. The unit was activated, and set to fire on a 1 minute 30 second cycle.

This lease has historically produced five barrels of oil daily for the last several years from the fifteen wells being pumped, based on the lease operators reports.

The test was scheduled to measure the increase of production collected at the tank battery over a sequel week test.

However, an unrelated grass fire resulted in most of the wells being shut down, primarily because of the destruction of a portion of the pipe collection system, and the burning of the electric lines leading to the pumps. This resulted in several days delay in the measurement scheduled.

During the period of this delay, the tool was removed from the well, as it was decided to replace the power cable to the tool, the reason being the original cable resulted in malfunction of the control panel due to "bridged voltage", which necessitated firing the tool at a lower voltage level.

New cable, sufficiently insulated to the control panel was installed on October 19, 1996. The only cable available was in two sections and required splicing. The fluid level in the well was 800 feet below the splice. The unit was reinstalled in the well at 2:30 P.M. on October 19th, and was fired through October 23rd. A variance in the down hole cable wire was noted, and the tool was pulled from the well on October 23, 1996 at 9:30 A.M. and the test was discontinued.

RESULTS, CONCLUSIONS AND RECOMMENDATIONS

RESULTS

1. During the testing period from October 19th to October 23rd, 1996, fluid levels and oil viscosity were increased in the treated well (oil level rose to 13 feet below surface level). After the tool was removed on October 23rd, the fluid level (oil) lowered on October 25th to 176 feet below surface level, and on October 26th to 290 feet below surface level.

This represents in upwards of fifteen barrels of fluid during the period of the test in the test well if recovered by pumping.

2. A significant increase in bottom hole pressure was noted in Well No. 28 (a flowing gas well) some 600 feet north of the treated well. Two barrels of oil were bled off under pressure.

CONCLUSIONS

The test was positive in spite of adverse and erratic conditions. The positive aspects are;

1. The tool fired without major deterioration of the capacitors (problems were in the power source cable and firing mechanism).

2. The action does result in increase in bottom hole pressure, probably from chemical change in the hydrocarbon valence.

3. Lateral effect was noted in spite of the lenticular structure of the Peru Sand.

SUMMARY

The results prove the application of the tool and concept. Limited refinement is required to allow a production, marketing and business plan to be implemented.

Respectfully submited,

Anthony Lane

DEFINITIONS OF TERMS

TOOL CONCEPT

The high voltage, high energy shock waves created by the tool will break the oil molecules or hydrocarbon chain to release gas from the oil molecule. This pressurizes the oil zone and increases the viscosity to push and allow the oil to reach the well bores. This results in an increase in production and recoverable oil.

BOTTOM HOLE PRESSURE

The P.S.I (pounds per square inch) of pressure which exists in the oil zone under discussion. Bottom Hole Pressure is that which forces the fluid to the well bore. Over the years this pressure declines, and the production of the well declines accordingly. Bottom Hole Pressure can be estimated by the lift of the fluid in the well bore (approximately 1/2 Lb per foot of lift).

VALENCE

The combining strength or capacity of atoms referring to Hydrogen as a standard. The force which determines with how many atoms of an element an atom of another element will combine.

LENTICULAR

Shaped like a biconvex lens.

ANTHONY LANE
P. E. & GEOL.
CONSULTANT

P. O. Box 5843
Tucson, Arizona
520-887-4632

OIL ENHANCEMENT TOOL
TECHNICAL REVIEW

August 27, 1997

INTRODUCTION

This review is prepared at the request of Lenard Manson, Chairman of Erika. The purpose of the review is to update the progression and development of the equipment, application and tests.

HISTORY

The system was introduced to Erika by Robert Redding in 1992. The prior application was not oil related. Mr. Manson, after analysis, conceived the potential for oil enhancement application. This resulted in redesign of the equipment to oil field applications. After redesigning, the tool was subjected to extensive field application and tests. This involved many modifications of the tool including capacitors, firing systems and materials. This test period was completed prior to commercial field testing and involved several well established research oriented companies.

APPLICATIONS AND FIELD TESTS (COMMERCIAL)

Commencing in 1995, the oil enhancement was tested on a commercial basis on existing oil production. The area selected was North Eastern Oklahoma, which is notorious for problem production, stripper and abandoned wells which are State regulated. The area contains multiple pay zones.

TEST RESULTS

The tool after further modifications resulted in significant increase in production from three separate test sites.

Test 1 Bushfield Lease (Fox) Rogers Co., Oklahoma
This test was undertaken in February 1995, on well completed Bartlesville formation over a period of seven days. The

tool was fired intermittently resulting in an increase of 135 percent.

Test 2 Desahazo-Slaveon Lease, Osage Co., Oklahoma
This test was undertaken in October 1996 on wells completed to the Peru formation, over a period of ten days intermittently for various reasons. However, an increase of 200 percent was noted when measurable.

Test 3 Spake Lease, Rogers Co., Oklahoma
This test was undertaken in November 1996 on wells completed to the Bartlesville formation over a ten day test period. An increase of 400 percent was noted.

CONCLUSIONS

The use of the tool directly enhances the production of oil. In all instances, natural gas was observed whereas, prior observations for gas were negative.

Laboratory and field tests directly show an significant change in the viscosity of the oil, which allows for greater permeability of the producing horizon.

Lateral extension of the tools effect is observable subject to the local geologic structure.

Respectfully submitted,

Anthony Lane

EXPLANAT ION OF ATTACHED CURRENT INDUSTRY REPORTS AND CLAIMS

As you read the attached reports and claims of the various methods currently being tested for increased oil recovery, you will note that the Pulse Technology method of the ERICA oil tool combines just about all of the various methods in one technologically advanced and ecologically friendly method. If you can imagine a bolt of lightning shooting into the oil zone structure, you will realize why this tool works. Each shot of the Pulse Power generated by the tool creates 10,000 volts and approximately 350,000 amps in 6 millionth of a second through the oil zone.

The following are capsule comparisons of the attached industry reports:

1. In one report there is a claim that **seismic** action increases the oil production. The ERICA tool definitely creates a much greater force than reported in this claim.

2. In the report that claims **sonic** waves increase production, in fact, the Pulse Power shock wave is stronger, faster and the pulse creates a similar wave.

3. There is the report that states that **pressure** increases production. The ERICA Pulse Power tool creates 3,200 foot pounds of pressure that is pushed into the oil zone.

4. The report that claims that **heat** increases oil production, you will note that the Pulse Power tool creates approximately 3,000 degrees centigrade of heat into the oil zone that, in fact, breaks the oil molecule thereby changing the viscosity of the oil.

In addition, the shape of the shock wave produced by the Pulse Power tool has a microwave effect as it goes through the oil zone that also creates increases the temperature through the zone.

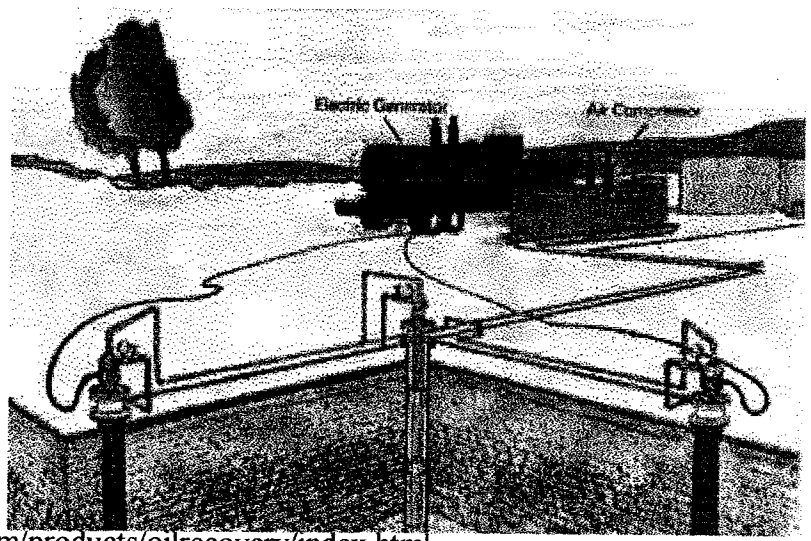
BIO Electrics.com™

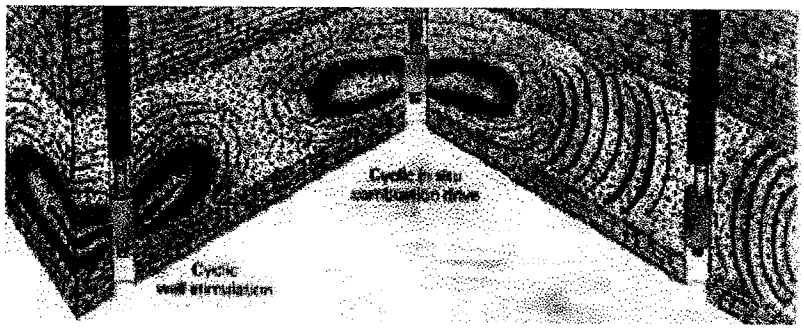
Electrofrac

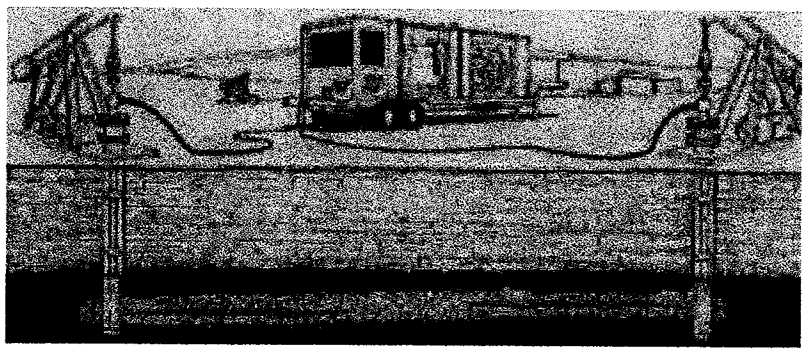
ELECTRO-ENHANCED OIL AND GAS RECOVERY SYSTEMS

- Oil production by electrofrac's tertiary recovery systems
- Research and development
- In situ electropyrolysis and electro-gasification of oil shale, coal and tar sand
- Electro-enhanced recovery of natural gas from devonian shale

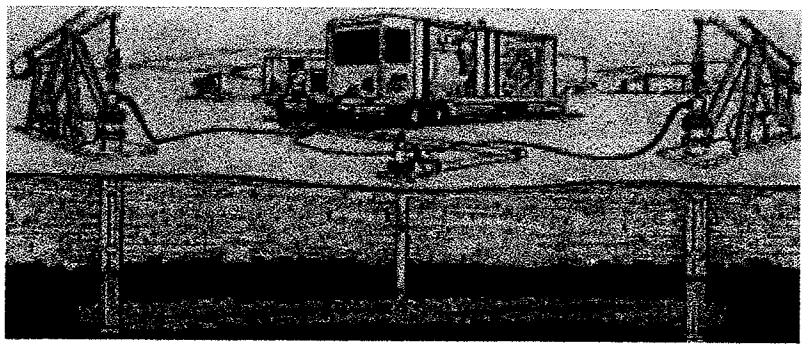
ELECTROFRAC-HEATFLOOD PROCESS



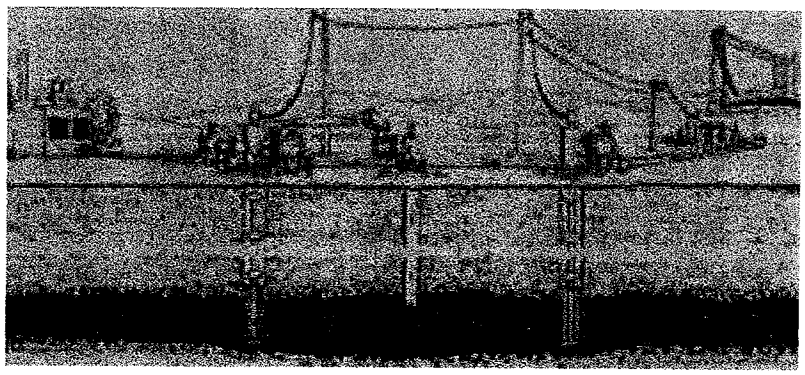




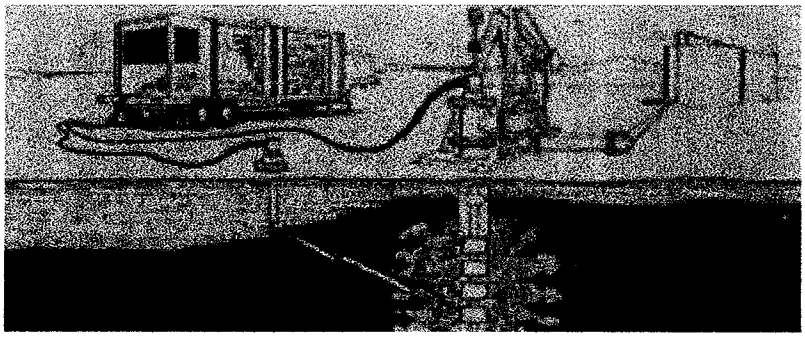
Process of Electric Oil Well Stimulation By Electrofrac Method.



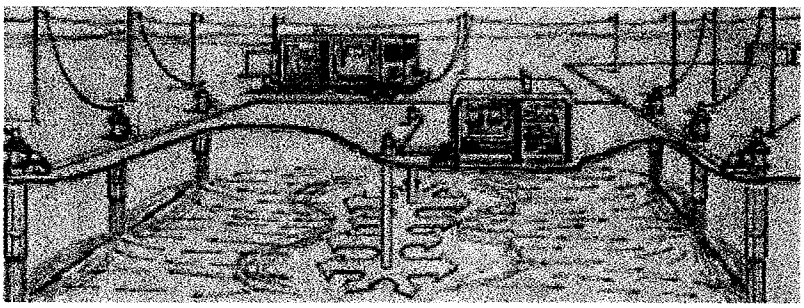
Process of Electropressurization of Oil Reservoir (Secondary Recovery).



Process of Electrogasifigation Of Solid Hydrocarbons.



Process Of Oil Flow Stimulation By Multipoint Electrode.



Process of Electrogasification Of Oil Reservoir (Secondary Recovery).

Enhanced Oil Recovery

Enhanced oil recovery from low productivity oil reservoirs is very important nationally and worldwide. Electrofrac Heatflood Process improves both the rate and overall extent of oil recovery. This process u electrical energy in combination with in situ combustion. Advantages include control over ignition and combustion. Permeability is also improved. The result is greater net recovery of oil through more effec flooding of the oil reservoir. An important multi-million dollar development and demonstration of this p currently underway in an oil field of southeastern Kansas. Additional developments are also in progress Electrofrac Heatflood Process is applicable generally to a large number of heavy oil deposits.

Synfuels Underground Production

Electrical energy can also be employed to recover synthetic fuels from coal, shale and tar sands withou Underground coal gasification has been initiated by means of electrical energy, followed by sustained gasification. In this application electrical energy is used in several ways: to create a carbonized path for flow, to create a pattern of fractures of fissures for gas to flow through the formation, and to initiate ar the gasification. In similar fashion, oil shale can be gasified or pyrolysed in situ without mining. Anothe application for Electrofrac techniques is the release of natural gas from Devonian shale formations in m eastern and central states.

Abstract

This paper will present the results of a field demonstration of a less known enhanced oil recovery proce

specially configured electric power unit, and facilities for injecting air and fuel into a controlled combus within the area stimulated. One essential feature is creation of electrically conductive paths within the c This is accomplished in either, or both of two mutually supportive ways:

1. Electrocarbonization of a small portion of the oil present between electrodes mounted in the oil s
2. Injection of electrically conductive pellets with, or in place of the sand normally injected during hydrofracing as part of the original well completion.

The process has been field tested successfully for the typical largely heterogeneous oil sands found in predominately fluvial deltaic formations. Field test was initially performed during 1979 and 1980 on a l named Beachner-1 located in the east-central portion of Neosho County, Kansas and again in 1983 to expanded to Beachner-1 and Beachner-2. The oil reservoir at the location is shallow and generally unp with essentially no natural driving pressure, and natural flow is typically just 1 to 3 gallons per day per about twenty feet of pay sand.

During the initial field test, an enhancement ratio of 4.5 to 5.4 was achieved relative to natural product though the field was only partially stimulated. Observed enhancement ratio during the second field test from 4.6 to 10.7 and the enhancement ratio at the other more remote wells ranged from 1.8 to 3.1 givi enhancement ratios of 2.4 to 5.5 for all wells on the lease at that time. Increased production was sustai more than two years through partial stimulation of the field containing fifty wells. The neighboring leas south also benefited indirectly form the stimulation of the Beachner-1 and Beachner-2 leases.

The Electrofrac Heatflood process facilities included a specially outfitted 500 KVA diesel electric gene Electrodes mounted down-hole in the oil sand, air and fuel injection facilities, and proprietary means fo distributing electric energy deep into the oil sand to promote heat cycles through controlled combustio patterns of injection and production wells.

The process has been proven to be an effective recovery technique for those reservoirs that because of of their heterogeneity the conventional recovery techniques fail.

Introduction

Application of thermal energy as primary, secondary and even tertiary oil recovery techniques has been the field with mixed results. It was initially considered a process suitable for the heavy oil reservoirs, b research and investigation revealed mechanisms involved in the thermal recovery processes that can be advantage of for light oil reservoirs as well. Examples of thermal recovery techniques are *in situ* comb more commonly known as fireflood, and the more advanced technique of steam flooding. Other less kn thermal recovery techniques are detonation of thermonuclear devices and the use of electrical energy. E energy can be used for bottom-hole heating within a single wellbore to initiate combustion, or to heat i produced fluid. Standard electrical igniters can usually be used for this purpose.

An alternate technique is to take advantage of, and alter the natural earth resistance between two elect spaced a considerable distance apart. This technique has been successfully applied to "electrocarboniza experiment with coal[1-4], tar sands[5], and oil shale.[6,7] Successful electrocarbonization and creation of electrofractures have been documented in the literature.[8-12] It seems to be feasible to take advantage o electrocarbonization and the eventual creation of electrical linkage to initiate combustion within the res from the wellbore. This process can be used as a stimulation technique for the kind of reservoirs that di front cannot be created because of the existence of the extensive natural fractures or simply because of

opportunity.

Application of electric energy has been demonstrated in other areas such as in situ electrocarbonization gasification of coal[2,4,13-17], electric rock fragmentation[18-22], recovery of oil from tar sands[5] and oil sh The Electrofrac Heatflood Process entails the use of down-hole electrodes mounted in the oil sand, a s configured electric power unit, and facilities for injecting air and fuel into a controlled combustion zon the area stimulated. One essential feature is creation of electrically conductive paths within the oil sand accomplished in either, or both of two mutually supportive ways:

1. Electrocarbonization of a small portion of the oil present between electrodes mounted in the oil
2. Injection of electrically conductive pellets with, or in place of the sand normally injected during hydrofracing as part of the original well completion.

The technique of electrocarbonization was first demonstrated with coal in both laboratory and field tria

Electrocarbonization is first initiated by applying relatively high voltage to electrodes mounted in situ. conductive carbon path is then created gradually between the electrodes. If continued long enough the phenomenon of electrolinking occurs, that is, the conductive carbonized paths grow from both electro they meet. At this point, overall resistance decreases sharply to a low level. Thereafter, the application causes heating along the carbonized path. The intensity of heat can then be controlled as needed to ach of several desired results, such as:

1. Heating the formation.
2. Steam generation and/or oil vaporization.
3. Ignition.
4. Sustaining partial or complete combustion.
5. Further carbonization and/or gasification in the surrounding formation, if desired.

Some of these options are exercised in the Electrofrac Heatflood process; primarily ignition and contro combustion.

Electrolinking in coal is illustrated in Figure 1, which shows the variation in resistance (i.e. impedance) time for both lab and field trials. Carbonized links of up to 150 feet were achieved. There is no theoreti the length that can be carbonized but shorter links can be created more rapidly, and with greater assura the directness of the path, which tends to be influenced by variations in conductivity that exist within th formations.

Project Site and Reservoir Properties

The project site is located in the east-central portion of Neosho County, Kansas as shown in Figure 2. at a depth of about 200 feet. It is trapped in deltaic fluvial channel sands and has deposits that form a depositional system averaging about one mile wide, and is elongated northeast within the Saint Paul-W

Oil rich sand is found at depths ranging from 180 feet to 210 feet, in the Peru formation. The Peru, a s grading from shale stringers near the top, to a slightly calcareous composition in the middle and base, a somewhere in the neighborhood of 20 feet in thickness. The environment of deposition was shallow m Hence the sand occurs in irregular island-like patterns of fluvial deltaic channel sands and has deposits varying degrees of thickness.

Permeability of the reservoir increases from top to bottom, and is directionally oriented SW-NE. The ic permeability near the top of the Peru is due to the existence of the shale stringers previously mentioned occurrence of shale serves as an entrapment (both vertically and laterally) to hydrocarbons in the reser

Oil saturation of core samples from the reservoir is roughly 52%, while total fluid saturation is around Additional parameters of the reservoir may be found in Table 1, which also contains a listing of wells a facilities on the leases. Core analyses are on file for twenty wells on the two leases. These are augment detailed drillers logs for about one hundred wells. The original coring from the oil sand have also been for further study.

The project site consists of two leases totaling 240 acres, called Beachner-1 and Beachner-2. Their loc Neosho County, Kansas are shown in Figures 3 and 4. They are both located in Township South, Rang A graphic presentation of a typical core log is presented in Figure 5, which shows oil bearing Peru sanc 200 feet. Permeability is low and varied ranging from below 20 to over 100 millidarcys. The isopach sk Figure 6 shows contours in the general area of the proposed demonstration sites.

There are a total of forty-seven wells in the Beachner-01 lease. Forty-five wells extend about two hund Peru sand. Average thickness of the oil sand is about 20 feet and contains proven oil under at least fort acres totaling an estimated 817,000 barrels. Two wells extend about four hundred feet to Bartlesville s has not yet been evaluated. Seventeen of the wells are fitted with electrodes in Peru sand. The site is w developed, including an oil gathering system, water separator, oil and water storage, gravel roads, elec access at each well, and surrounding fences along property lines.

The reservoir is predominately fluvial deltaic formation type, as typified by those in the Cherokee Basir Kansas. Crude oil in these formations is generally light, and has properties similar to the crude oil inspe results in Table 2 for a sample taken from the project site. This oil is hard to recover, not because of its character, but because of unfavorable reservoir characteristics, such as have been observed on that sam

Although the formation is "tight," which could alone be a major problem, the greatest difficulties are ca the highly heterogeneous character of the oil sand. The overall permeability of the oil sand is in the ran md. The main problem is heterogeneity. Within just a few feet of oil sand, large variation of permeabilit observed both above and below the wide range of 25 to 150 millidarcys. In addition, some of the vario stringers in the formation can only be a few millidarcys, thus creating serious lateral longitudinal, as we vertical variation observed in core samples. The problem is compounded in many areas, such as the demonstration site by little or no significant natural reservoir pressure.

These characteristics have caused failure of the best known alternative methods of recovery, which incl various adaptations of water flooding, pressurization, and steam or fire flooding, because of the channe all efforts to move oil along a controlled "front." Various techniques have been found to overcome this somewhat, but with some unavoidable deterrent to mobility of the oil.

The Electrofrac Heatflood process provides significant advantage in two ways. First and most importa ability to create conductive paths, and to direct intense electric energy deep into the oil sand. This perm electrical heating where it is most needed. But more importantly it allows more complete, and more ec heat generation by igniting controlled combustion beginning where it is most needed. Oil recovery is th enhanced mainly by heating to increase mobility of the oil. Combustion products and heating then prov perhaps gentle, but well directed internal driving force. The benefits of this effect are maximized by me periodic, or cyclic stimulation, so that some oil can flow back to the stimulation well as well as outwar distant wells.

Field Demonstration Results

Electrolinking was demonstrated in the oil sand at the Beachner-1 lease. A pictorial concept of the proc installation is presented in Figure 7. The electrode used is shown in Figure 8. Results are shown graphi Figure 9. About ten hours were required to create a carbon link between electrodes set down-hole into sand at wells located two hundred feet apart. Electrolinking was repeated at other pairs of wells. Cross a second path perpendicular to the first was also achieved.

Complete linkage is not necessarily needed for the Electrofrac Heatflood process, when conductive pat been extended into the oil sand by alternative means. However, when this is done, repeated stimulation introduce the benefit of a greater reach into the oil sand through progressive carbonization, even to the complete linkage. A more typical stimulation run lasts only about two to three hours, as shown in Figu stimulation run was conducted at wells that had been hydrofraced with aluminum pellets in place of the conventional sand used as propant.

The Electrofrac Heatflood process has been advanced from the original research through two importan applications which demonstrate ability to greatly enhance oil production from the reservoir. All these st development were carried out predominantly in the field; and in the same oil reservoir presented here. I results give a direct indication of operating procedures to be employed, and the extent to which oil pro may be enhanced by means of Electrofrac Heatflood process.

The original field research in 1960-1985 included both air injection studies and electrically enhanced in combustion. Repeated air injections totaling 1.1 million cubic feet over an elapsed period of 72 days pr significant enhancement in themselves. This should have been ample to pressurize many acres of oil sar However, it was eventually realized that the heterogeneous nature of the reservoir allowed selective ch and hence no effective driving force toward the producing wells. Subsequent trials with the combinatio injection and intermittent electrical stimulation, did, however, enhance oil production significantly.

This capability was demonstrated effectively during later trials inspired by strong oil prices in 1959-19€ Beachner-1 lease. The overall result has been presented in Figure 11, where production was enhanced l of 4.5 to 5.4 during periods of intermittent (cyclic) stimulation. Figure 11 shows oil production before, and after field trials at the Beachner-1 lease during 1979 and 1980. The enhancement ratio of 4.5 to 5.4 achieved relative to natural production, even though the field was only partially stimulated.

Better evidence of effectiveness was recorded in a later commercial scale trial during 1983. Detailed re presented in Figure 12. Figure 12 shows oil production measurement at individual wells in a five-spot t during an early part of that work. The average production from test wells was enhanced by ratios of 5.: at a 5-spot test pattern where electrical stimulation, air injection, and cyclic heating were introduced at well. Combustion air was injected to the well at the center-spot. Power was also applied intermittently electrode in that same center well. The bottom of Figure 12 is overall production from the 17 wells wh then in service. Rates of production increased sharply upon stimulation, and subsided gradually after, u next stimulation which caused further increase until production from the 5 wells in the test pattern far € the original production from all 17 wells. Observed enhancement ratios at the five-spot test pattern ran 4.6 to 10.7 The enhancement ratio at the other more remote wells ranged from 1.8 to 3.1 giving overal enhancement ratios of 2.4 to 5.5 for all wells then on the lease at that time. An overall view of results c stimulation during 1983 to 1985 is shown in Figure 13, which shows historic annual production for the Beachner-1 and Beachner-2 leases combined, and for neighboring leases to the south that also benefite indirectly from the stimulation and cyclic heating conducted at some of the wells on the Beachner-2, an Beachner-1 leases. The overall enhancement ratio at the Beachner-1 and Beachner-2 leases reached 10

Results to-date represent only partial stimulation of the Beachner-1 and Beachner-2 leases. Production raised as high as 30 barrels per day. But a series of problems were encountered, including severe weath low product revenues due to rapid decrease in world oil prices. If the combination of financial resource prices had remained sufficient, it was estimated that overall production should have been increased stea much as 100 to 200 barrels per day within about three to four years at both leases. It was also estimate process would be economical and competitive with world oil prices even at much lower production rat

General Observation

Fluvial dominated deltaic reservoirs, though extensive nation wide, are notorious for their lack of respc enhanced recovery methods in general. This is caused by inherent reservoir characteristics, often low permeability, but more importantly, wide variations in porosity and permeability which cause serious cl As a result pressurization and ordinary flooding with a conventional style displacement front tend to be ineffective.

Prior success with the Electrofrac Heatflood process is believed to result from its unique ability to exte energy into the formation along paths guided not by the higher permeability and/or porosity channels, b somewhat more dense, and relatively independent channels that tend to favor passage of electric currer current in turn generates greater conductivity and additional permeability through a resulting network c carbonized materials. In this way, both the electric energy, and follow-on cycles of controlled in situ co distribute heat where it will more effectively induce flow through viscosity reduction.

Such effects cannot be demonstrated meaningfully in laboratory or bench scale test because the crucial the reservoir are only partially understood and do not lend to in vitro stimulation. Only full field scale o can illustrate ultimate effectiveness.

Need for some fine tuning of the process is also anticipated. Some of the important variables include te of well preparation. It is presently believed that hydrofracing with an electrically conductive inert propa superior to conventional hydrofracing such as chemical or explosive treatments. Alternatives such as hc drilling may also provide some benefit. The optimum extent of electrocarbonization, that is duration of electrical stimulation, need further study. Variations in the amounts and timing of air/fuel injections ma to an improvement to the cyclic variations in heating, thereby inducing back-flow production at the stir well. The possible benefits of in situ steam generation can also be studied given sufficient time and func technique could lead to marked improvements in the rate of displacement of oil by generating steam dii within some of the lower porosity zones that are relatively susceptible to electrocarbonization, and hen subsequent heating, expansion of fluids, and viscosity reduction.

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	Beachner-1	**Beachner-2**
Location in Neosho County, Kansas	East 1/2 of NE 1/4 of Section 21 Township 29 South Range 21 East	Southwest 1/4 of Section 15 Township 29 South Range 21 East
Peru Sand		
Approximate Depth, Feet	200	200
Average Thickness, Feet	20.4	16.7
Proven Acreage	41.8	71.0
Present Oil Saturation, Percent	65	63
Residual Oil Saturation, Percent	36	36
Water Saturation, Percent	30	33
Known Oil In Place, Barrels	817,000	1,100,000
Oil Wells		
Conventional - Peru Sand	28	17
- Bartlesville	2	--
Electrowells - Peru Sand	17	32
Total Cemented & Hydrofraced	47	49
Pumps & Motors	46	41
Gun Barrel	1	1
Storage Tanks		
Oil - 100 Barrels	3	4
Water - 500 Gallons	1	2
- 1000 Gallons	-	2
Fences	Complete	Complete
Roads - On Site	Gravel	Gravel
- Access	Kansas Highway 47	Kansas Highway 47
Shared Facilities		
Metering Pump	4	
Fuel/Water Injection System	1	
Electofrac Power Unit, 500 KVA	1	
????Compressor, 500 HP	1	
Mobile Office/Lab	1	
Off-Site Office & Shop	1	

Table 2
Crude Oil Inspections from Peru Sand

Gravity, API
Specific Gravity, 60°F/60°F
Pour Point, °F

Viscosity at 70°F, cp
Carbon Residue, Conradson, wt%
Heat of Combustion, BTU/bbl

ASTM Distillation:

	°F
Initial Boiling Point	170
10%	294
15%	340
20%	404
25%	454
30%	482
35%	496
40% & Over	Erratic results due to craking in the still

Hydrocarbon Types, Vol.%

Paraffins	22.8
Olefins	none indicated
Naphtheries	17.2
Aromatics	56.3
Asphaltenes	3.7
	100.0

Component Analysis, wt% (dry basis)

Carbon	84.96
Hydrogen	12.42
Nitrogen	0.18
Sulfur	0.62
Ash	0.16
Oxygen	1.66
	100.00

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Table 1

State-of-the-Art Technology Summary

Advances in Seismic Stimulation Technologies

by Susan Jackson, RMC, Inc. for DOE's National Petroleum Technology Office, Peter Roberts, Los Alamos National Laboratory, Ernie Majer, Lawrence Berkeley National Laboratory

Excerpts in *PTTC Network News*, 2nd Quarter 2001

Seismic wave stimulation technology has the potential for being a relatively low-cost procedure for enhancing oil recovery in depleted fields, or returning some shut-in wells to production. Tests indicate that potential is greatest in fields with high water-cut and large amounts of immobile oil, making mature domestic reservoirs a prime target. Field tests of the technology, however, have yielded promising but mixed or inconclusive results.

Interest in seismic stimulation started in the 1950s with observed correlations between water well level and seismic excitation produced from railroad trains and earthquakes. It was noticed that a rise in well fluid levels and an increase in fluid (pore) pressures were associated with earthquakes and cultural seismic noise. Similar effects were observed in producing oil fields where distant earthquakes caused increases in production, and wells close to operating machinery, highways or railroads appeared to produce more oil than wells in quieter areas. These anecdotal observations motivated Russian researchers to perform surface Vibroseis stimulation tests in several producing oil fields. The results of these early field tests were mixed. In some fields, production increased after Vibroseis stimulation, but in others the production actually declined. It became clear that a better understanding of the stimulation phenomenon was needed before it could be exploited reliably. This led to numerous research efforts beginning in the early 1970s and continuing today. Beresnev and Johnson (1994) provide a comprehensive review of over 100 Russian and U.S. technical articles and patents on the effects of seismic and acoustic stimulation on fluid flow in porous media, including laboratory investigations, theoretical studies and field tests. Documented work covers the use of a wide range of stimulation wave types and energy coupling modes, with frequencies spanning the range of one Hz to five MHz.

Prism Production Technologies, Edmonton, Alberta, Canada

Sonic Production Systems, Aimes, IA

References

stimulation for enhancing environmental remediation efforts, particularly at oil refineries where large spills of petroleum products are threatening groundwater quality. Numerous oil companies and seismic source providers have expressed interest in pursuing this application. Recent research has indicated that seismic waves could enhance the extraction rate of groundwater contaminants by as much as a factor of 20 under ideal conditions (Roberts et al., 2001). However, the technology has been even less well tested in the field for environmental remediation than it has for oil production enhancement

This article summarizes recent research efforts and describes several existing field stimulation technologies. During the last ten years industry interest in seismic stimulation technologies has grown enormously. Along with this increased interest, our understanding and validation of the phenomenon are also beginning to improve. Industry and government supported research efforts are largely responsible for this. The science and technology are at a critical stage of development now, where continued research and applications testing efforts have an excellent chance of answering many of the important questions that have been raised regarding when, where and how seismic stimulation can be used reliably.

Mechanisms of Increased Recovery

Mechanisms responsible for improved recovery are not well understood and remain the subject for further research. The following mechanisms have been proposed to explain the changes in fluid flow characteristics resulting from seismic stimulation.

- *Changes in Wettability.* Some laboratory work indicates that the wettability of a core saturated with oil can be made more water wet, resulting in increased oil recovery rate by waterflooding in conjunction with seismic stimulation.

- *Coalescence and/or dispersion of oil drops.* This school of thought speculates that attractive forces acting between oscillating droplets of one liquid in another (Bjerknes forces) induce the coalescence of oil drops, enabling continuous streams of oil to flow.

- *Reduced viscosity.* Laboratory work has indicated that, immediately after a 30- to 60-minute long exposure to an acoustic field, oil viscosity dropped by 20-25%, then gradually returned to pretreatment level over a 120-hr period. Similar viscosity reductions of 18-22% have been noted with polymers exposed to an acoustic field. One researcher suggests that heat generated by ultrasound absorption contributes to viscosity reduction.

- *Surface tension.* Under some theories, it is suggested that the fundamental source of the increased permeability is the reduction in surface tension caused by the differential velocity between the rock matrix and the pore fluid.

- *Increased permeability.* It has been speculated that seismic waves can disrupt immobile fluid boundary layers on pore walls, which would increase the effective cross section of pores. In early laboratory work, the permeability of a core sample saturated with fresh water increased 82-fold after being exposed to an acoustic field, returning to its original value within minutes after removal of the sound field. It has also been demonstrated that stress cycling of core samples at 50 Hz can mobilize in-situ particulates that are plugging pore throats. The pore throats are unplugged and the rock's permeability increases.

DOE-Funded R&D in Acoustic Stimulation Technology Development

Two projects have been funded by DOE's National Petroleum Technology Office in Tulsa, one with Los Alamos and Lawrence Berkeley National Laboratories involving laboratory, modeling, and field experiments and a second with Oil & Gas Consultants International, Inc. (OGCI) involving field testing of a vibration stimulation device in Osage County, Oklahoma.

Los Alamos National Laboratory and Lawrence Berkeley National Laboratory

Los Alamos National Laboratories (LANL) is partnering with Lawrence Berkeley National Laboratories (LBNL), University of California at Berkeley (UCB), AERA Energy LLC, Applied Seismic Research Corp., Chevron, Conoco, Fluidic Technologies, Halliburton, Marathon, Oil & Gas Consultants International, Inc., PerfClean Intl., Phillips, Piezo Sona-Tool, and Texaco to study seismic stimulation.

The research objectives of this project are to investigate the physical conditions or mechanisms by which low-frequency (1-500 Hz) stress (seismic or acoustic) waves enhance oil production rates in marginal reservoirs. Anecdotal evidence and limited field testing have indicated that seismic stimulation can increase oil production rates by 50% or more, but it is currently difficult to predict how, when or where to apply the technique successfully. Research is focused in three main areas: (1) laboratory fluid flow and production enhancement experiments on cores, (2) numerical and theoretical modeling of wave stimulation effects on 2-phase fluid flow in porous media, and (3) full-scale experimental field stimulation testing, source characterization, and production monitoring.

Laboratory Experiments

Both steady-state constant flow and non-steady-state displacement tests were performed in Berea Sandstone using oil/brine and decane/brine systems. During steady-state experiments, the drop in pressure increased in the oil/brine system, while it decreased with the decane/brine system. Two possible

explanations for the pressure increase in the oil/brine system are 1) additional oil and/or brine became trapped or 2) additional oil began flowing through a fraction of the pore space previously occupied by mobile brine. The pressure decrease observed during decane/brine flow could be explained by 1) previously trapped decane and/or brine becoming mobilized or 2) decane with its lower viscosity replaces flowing brine.

Non-steady-state displacement (flooding) tests using both oil/brine and decane/brine systems indicated that stress stimulation enhances brine production during drainage (oil flood) and decreases the oil displaced during imbibition (brine flood). These observations could be explained by the fluid-trapping mechanism mentioned above. Stimulation may cause the highly water-wet Berea sandstone to become temporarily more oil wet, causing oil to become trapped during stimulation. With the decane/brine system, stimulation had little or no effect on net fluid production during either drainage or imbibition. During imbibition, however, the rock reached residual decane saturation faster. Altered wettability cannot account for this observation.

Modeling

Modeling work strives to describe how each individual component of oil and water should respond to a pressure pulse in a porous medium. During the past year, the exact equations for mass and momentum balance among all three components in an elastic porous medium containing two immiscible fluids has been derived in the linear limit. These equations lead to diffusion equations for pressure/stress and for porosity (or total fluid mass) in the long-wavelength limit. The work will allow a more exact calculation and understanding of the coupling of different seismic and pressure effects. This work is being extended to the long-wavelength limit by developing coupled partial differential equations for wave propagation and solving them under boundary conditions appropriate for fluid pressure-pulsing experiments. The ultimate goal is to model performance in different geologies and formations as a function of porosity, and fluid and matrix properties.

Field Tests

LBNL and industry partners have conducted several field tests to monitor the seismic energy in the formation resulting from stimulation activities. The tests consist of careful measurements of the pattern of effects of the stimulation correlated with the measurement of seismic energy at various distances from the seismic source.

The tests have been conducted by lowering a three-component geophone and hydrophone array into wells at distances varying from 200 feet to 2300 feet during the stimulation period to record the seismic energy. With these data, the level and bandwidth of energy produced in the reservoir can be observed. The data collected are also correlated with production increases in the wells to deduce the relationship to other factors, such as differences in geology.

To date, three different sources in three different formations have been tested. The tests have been in the sandstone formation of the oil fields just north of

Loveland, Colorado, the diatomite in Central California and a shale formation also in Central California. Bandwidth ranged from 2 to 2,000 Hz. In all of these tests, no seismic energy above background was observed. It is thought that monitoring equipment was too far away. Future tests will place sensors much closer (within 100 feet). In addition, the pulse in the source will be monitored by placing a wide bandwidth and large range pressure transducer in the perforated sections of the source well.

For additional information, visit http://www.ees4.lanl.gov/stimulation or contact Peter Roberts, Los Alamos National Laboratory, phone: 505-667-1199, email: proberts@lanl.gov or Ernie Majer, Lawrence Berkeley National Laboratory, phone: 510-486-6709, email: elmajer@lbnl.gov.

Field Testing in the Osage Reservation, Oklahoma

Oil & Gas Consultants International, Inc. (OGCI) is partnering with the Osage Tribe, Calumet Oil Company, the field operator, and Phillips Petroleum Company (Phillips) to test vibration stimulation in the North Burbank Unit, a mature waterflood field located on Osage tribal lands. Discovered in the 1920s, the North Burbank Unit still has more than 200 million barrels of movable oil in place, but currently produces only 1200 bbls/day at 99% WOR. The Burbank sand is at about 2800 ft with permeability ranging from 50 md to one Darcy. Seismic Recovery LLC, a subsidiary of OGCI, has designed and built, and will test, a new version of a downhole vibration tool based on their patented whirling orbital vibrator. The tool developed by OGCI uses a backward whirling motion to create both compression and shear seismic waves from 5 to more than 500 hertz, and is capable of generating controllable force levels up to many tens of thousands of pounds. Two sets of mechanical slips are used to transmit the vibration energy from the backward whirling mass into the producing formation. A schematic of the tool is shown in Figure 1.

The direct mechanical contact with the formation allows the device to be used in reservoirs with a gas cap—a situation that would dampen a fluid pressure pulse technique. The tool can be used to mitigate the effects of near wellbore condensate dropout and for groundwater remediation, and functions equally well in producing and injection wells.

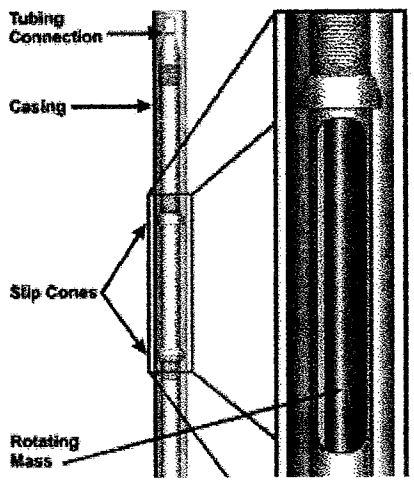

Figure 1. Schematic of Seismic Recovery LLC's 7-inch downhole vibration tool.

The downhole tool and surface power source will be tested in a newly drilled well that will be cored, logged and completed with 7-inch production casing. Phillips will conduct laboratory tests using their proprietary sonic core apparatus to determine fluid flow response to a range of vibration frequencies. Results will guide final adjustments to the frequency generation mechanisms of the downhole vibration tool. Drilling is planned during July 2001. Once baseline data are gathered, vibration stimulation will begin.

One or more offset wells, adjacent to the vibration test well, will be equipped with downhole geophones to determine strength of signal and if the producing formation has a dominant frequency response. Surface geophones will also be set out and arranged to pick up the signal generated by the downhole vibration tool. The results of the data collection will be a matrix of varying vibration stimulation conditions corresponding to changes in production fluid rates and seismic responses.

The results of the downhole vibration stimulation test will be made available though Society of Petroleum Engineers papers and workshops. A technical session on vibration stimulation will be offered at the SPE/DOE Thirteenth Symposium on Improved Oil Recovery in Tulsa, April 2002, bringing together the world's experts in this emerging technology.

Seismic Recovery LLC is actively seeking other opportunities to field test its tool for vibration-enhanced recovery, ground water remediation, and condensate dropout mitigation. *For more information contact: Bob Westermark, Seismic Recovery LLC, Phone: 918-828-2543, Email: bwestermark@ogci.com.*

Other U.S. Work by Producers

BP is looking into the use of pressure pulsing for EOR, well-bore cleanup, pipeline problems and drilling. In preparing for field trials, they have screened reservoirs looking for onshore, low gas content, and "softer" rocks to allow fluid-rock coupling. Five candidate reservoirs have been selected from about 300 reservoirs.

Chevron is currently applying in-situ seismic stimulation technology in their Lost Hills Field to lower their stimulation costs. Results of the stimulation are being monitored through observation wells and will be published.

AERA Energy has tried seismic stimulation (in cooperation with LANL) in their Lost Hills, San Ardo, and Belridge fields. Two or three additional field tests are planned. Lost Hills and Belridge fields, among others, are being considered for the test.

Marathon conducted a test in the Tensleep in Wyoming, a high viscosity oil reservoir. Tool failure and lack of resources prevented completion of the test. The formation was hard and fractured, resulting in water cycling problems. The resulting reduction in injectivity was attributed to mobilization of high viscosity oil. Marathon is considering another test of the technology.

Future Research Directions

Although tests and applications of seismic stimulation technology have been generally successful, further work is required to improve the reliability of the technology. Some of the areas that need further work include:

- Increased understanding of fundamental science and physical mechanisms governing the phenomenon
- Well-controlled field tests of vibration technologies
- Application of the technology to enhance other recovery methods, such as thermal recovery and chemical flooding
- Use of acoustic, elastic wave stimulation to obtain reservoir imaging information along with reservoir stimulation

Commercially Available Acoustic Stimulation Tools

Service companies with commercially available acoustic stimulation tools were invited to describe their tools, and four –Applied Seismic Research, PerfClean, Prism Production Technologies Inc, and Sonic Production Systems -- responded. Some other known suppliers were not able to respond.

Applied Seismic Research, Plano, TX

Applied Seismic Research (ASR) uses in-situ seismic stimulation (ISS) to mobilize immobile oil through creation of high-energy (up to 10 million watts of power) low-frequency shockwaves that enhance oil mobility. The ISS Tool has increased oil recovery and production by as much as 30% and has improved recovery in wells as far away as 1½ miles from the tool.

The ISS Tool consists of two modified tubing pumps separated by several sections of tubing (Figure 2). A conventional pumping unit powers the ISS Tool. On each cycle of the pumping unit, the tool releases highly compressed wellbore fluids creating seismic (hydrodynamic) shockwaves. In an oil-bearing reservoir, the shockwaves transform into localized, high-frequency wave fields that act to dislodge oil droplets and/or coalesce thin oil films into mobile oil droplets.

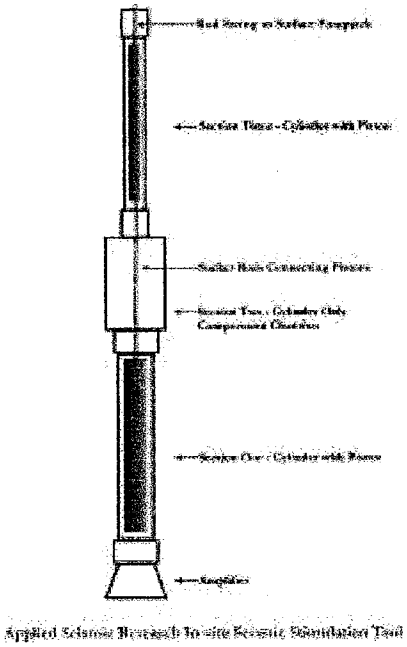

Figure 2. The Applied Seismic Research In-situ Seismic Stimulation Tool.

ISS has been proven effective in sandstone, dolomite, and diatomite reservoirs with permeability ranging from 0.0001 to 1 Darcy, API gravity ranging from 17 to 38 degrees, and on both fractured and non-fractured systems. Typically, ISS is most effective in reservoirs having a relatively low (field-wide) gas-oil ratio, less than 2000 scf/stb, API gravities greater than 20-22 degrees, and heterogeneous reservoirs containing areas of by-passed or trapped oil. Reservoir rock type, depth, and wettability do not significantly affect performance.

Requirements for technology implementation are a pumping unit of 120 or 144" stroke length having 6 to 7 strokes per minute, tubing, and rods. ASR provides the tool and on-site consulting for installation. The tool can be installed in active injection wells that remain active during ISS and in production wells provided the tool can be set at or below the bottom set of perforations.

A recent field test conducted in conjunction with Lawrence Berkeley National Laboratory, Los Alamos National Laboratory, and Chevron in Chevron's Lost Hills field illustrated the ability of the ASR ISS tool to enhance oil production and recovery. The ISS tool was placed in an active injection well at a depth of approximately 800 feet. It was run continuously at seven strokes/minute using a 120-inch conventional pumping unit. The seismic waves created every 8.5 seconds by the slimhole version of the tool had an average power of 1.5 megawatts (million watts). The seismic shockwaves traveled down the wellbore to connect hydraulically with the formation through the perforations at 2,200 to 3,600 feet.

A continuous 12-day stimulation test conducted during July 2000 increased oil

cut with no overall increase in fluids. A longer 38-day test performed during October-November 2000 in a group of 60 wells increased oil cut and oil production by 11% and 17%, respectively. Because many of the 60 wells had undergone various types of workovers and fracture stimulation, a control group of 26 wells that had not been disturbed by stimulation procedures was also monitored. By the end of the second stimulation treatment, oil cut from the 26 control wells had increased 29% and oil production had increased by 26% (see Figure 3).

Increases in oil production and oil cut attributed to a series of earthquakes occurring in September and October of 1999; the epicenters of which were located approximately 230 miles from the Lost Hills field, are also evident in Figure 3. The earthquake and ISS events are statistically significant as each event has pre- and post-event trendlines. Since oil production and oil cut curves both return to original trendlines, continuous application of ISS in the Lost Hills reservoir is required.

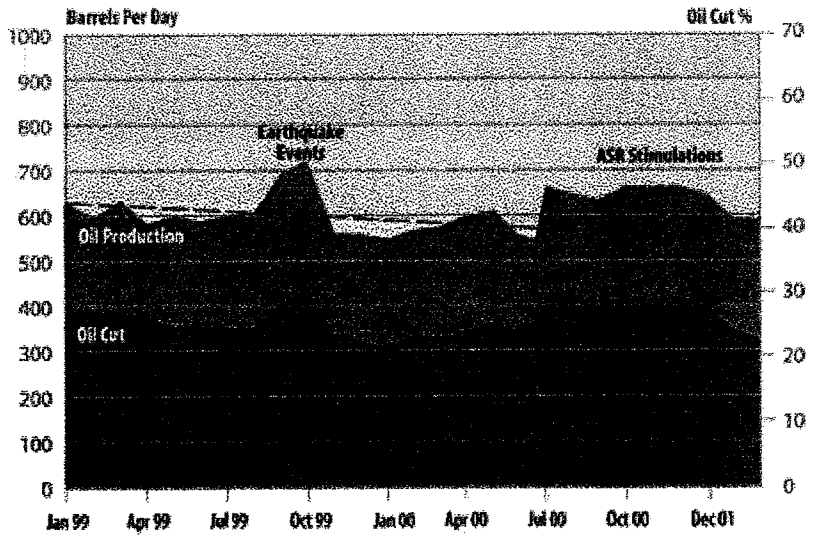

Figure 3. Oil production and oil cut data from a controlled subset of 26 producing wells from the Lost Hills field, California. Historic production data show a clear response to a magnitude 7.1 earthquake in October 1999 and to downhole stimulation treatments performed during July - November 2000.

For further information about the ISS Tool, contact Bill Wooden, phone: 972-381-4236, email: wow@zowi.to

PerfClean, Midland, TX

Although the PerfClean© Tool System is used primarily for near wellbore clean up, a field test to demonstrate applicability for enhancing recovery is planned in a South Texas field. The system uses a patented fluidic oscillator that creates pulsating pressure waves within the wellbore and formation fluids. These pressure waves break up any type of near wellbore damage, restore, and enhance the permeability of the perforations and near wellbore area. The PerfClean© Tool System is run into the well via coiled tubing, conventional

tubing, wash pipe or drill pipe. The desired treatment fluid (acid, water, seawater, diesel, nitrified fluids, etc.) is pumped down the tubing through the PerfClean© Tool.

The kinetic energy of the pressure pulse travels through the wellbore fluid with no appreciable energy loss. When the pressure wave contacts the formation, the energy is "dumped" and the process of removing the near wellbore damage is initiated. As the damage is removed and the permeability is restored, these pressure waves penetrate deeper and deeper into the formation. The pressure waves expand in a spherical fashion from the point of origin, which ensures that 360-degree coverage is accomplished, while moving the tools through the interval. The acoustic streaming induced by the oscillator focuses the treatment fluid and tool energy and allows for treating specific intervals.

The PerfClean© oscillators are true fluidic oscillators. There are no moving parts. They do not rely on cavitation to create pressure waves. There are no packer elements to fail. Unlike mechanical tools, which suffer from high-energy losses, the PerfClean© oscillator maximizes the energy potential of the pumped fluid.

PerfClean tools have been used to treat over 2,500 wells in 12 states and 7 international areas. The majority of these treatments have taken place in the Permian Basin region of Texas and New Mexico where PerfClean International Inc. is currently based. The tools have been successfully used to treat and correct near wellbore damage in wells ranging from 90' to 27,000' deep. The treatment design and execution varies according to well conditions and the goals of the operator.

Applications of the technology are best in formations that can support a full column of fluid. This allows for easy manipulation of the wellbore pressures during the treatment. Theory and experience show that incompressible fluids provide the best coupling of the pressure pulse generated by the tool to the formation.

For further information, contact David Facteau, phone: 915-686-7432, email: PerfClean@hotmail.com.

Prism Production Technologies, Edmonton, Alberta, Canada

Prism Production Technologies provides Pressure Pulse Technology (PPT), a technology that improves recovery through large but elastic-range (reversible) excitation implemented through tailored pressure impulses within the borehole. The method concentrates energy in the right frequency range for porosity dilation wave generation, and because the tool is at hole-bottom, energy losses that occur as a pressure pulse travels down a wellbore are avoided.

PPT has been used to solve environmental problems. Here, the types of problems are physically similar to those encountered in the petroleum industry except for two major factors; the pressures are much lower because of the

shallow burial and there is often a phreatic interface close to or within the aquifer.

PPT can be used to increase production of conventional and heavy oils using primary, secondary, and tertiary recovery methods as well as single well stimulations. The greatest potential of PPT lies in the application of the technology to the field scale where fluid flow rates to individual wells or groups of wells are increased. In past applications, perforations were kept open and flowing by continuous destabilization of perforation sand arches. In heavy oil reservoirs, incidents of sudden massive sand influx into sand producing wells, causing pump blockages were reduced. In low permeability reservoirs, injectivity of liquid floods was increased.

The PPT increases flow rates, reduces mechanical and capillary flow blockages, and improves sweep efficiency and resource recovery ratios. To achieve these effects, dynamic energy at an appropriate magnitude and frequency is introduced to the reservoir through pressure pulsing. This must be applied correctly, in an optimum configuration, as with any other type of enhanced oil recovery process. To decide the optimum approach to PPT in a producing reservoir requires knowledge of reservoir history, current reservoir conditions, and the options available for continued development.

The presence, quantity, and distribution of free interstitial gas affect the physical propagation of the porosity dilation wave. Wave propagation is impeded by free gas in either a continuous phase or a bubble phase. The gas compresses during the transit of a porosity dilation wave and can lead to an increase in the attenuation rate of the wave.

The area influenced by PPT depends on a number of factors. In one case, flow enhancement propagated slowly outward for a distance of 1000 m in a heavy oil ($\mu \approx 10{,}800$ cP) reservoir after a period of 10 weeks. Because the porosity dilation wave follows all the laws of physics associated with waves, it attenuates because of geometric spreading. However, because there is a pressure build-up effect associated with the porosity dilation wave, pressure diffusion spreads out from the source at a rate controlled by the permeability and the viscosity of the liquid phases. If the outward propagating pressure front is intercepted by production wells (sinks), they will arrest propagation of the effects. The spatial distribution of the PPT impulse devices with respect to the existing or proposed well locations must be optimized.

The PPT method is based on a rigorous theoretical construct that successfully predicts a number of phenomena that have now been observed and that follow the laws of physics. These include spatial attenuation, pressure diffusion, and gravity segregation of fluids of different density. For example, although PPT increases the rate of flow through the application of additional energy in the optimum dynamic range, the rate of flow is still controlled by viscosity, pressure drop, and permeability. Therefore, the presence of permeability barriers is as serious an impediment to successful PPT as it is to other methods that depend on permeable connections. In addition, it is important to

remember that PPT suppresses the various viscosity-dominated instabilities such as fingering, channeling, and coning. The suppression occurs because the pulsing energy is applied in the right area to push forward protruding fingers and increase sweep efficiency. Permeability barriers, disposition of strata, permeability ratios, and similar factors all have an effect on the fluid flow regime, even if flow rate is enhanced by PPT. These factors, therefore, must be assessed before implementation.

Requirements for implementing the PPT include well production history from the date of the last re-completion or significant operational change that would affect the ability to produce fluid, as well as the production history of the six-month period immediately preceding the pulsing, irrespective of interventions. The instantaneous background production rate and trend of each well immediately prior to pulsing initiation can then be more or less rationally extrapolated from the historical data. Since the reservoir production rate evolves dynamically and tends to follow the natural (expected) trends, this background period is considered sufficient, particularly since a number of offset production wells will likely be used for project evaluation. This approach allows project success to be evaluated rationally, despite difficulties in developing clear well histories and standard concerns about data quality. Production history details and intervention activity for the six to twelve months prior to the proposed date of PPT implementation must be used to develop base line trends that are used to evaluate program success.

For further information, contact Brett Davidson, phone: 780-486-2222, *email:* brett@prismpt.com

Sonic Production Systems, Aimes, IA

Sonic Production Systems, a business unit of Etrema, offers the PowerWave technology for enhancing production. The technology consists of two magnetostrictive (an alloy that changes shape and produces a powerful force in the presence of a magnetic field) actuators opposing an acoustic element. The set up of the tool is similar to that of an electric submersible pump. The PowerWave tool is a solid-state source with only three moving parts-two output shafts and one acoustic element. This provides for a long tool life. The tool runs at 250-400 Hz (cycles/second) continuously. Produced pressure waves act to decrease surface tension between oil and pore walls; destroy surface films that cover pore throats, allowing the oil to move out of the pore; and coalesce oil droplets so they can move to the wellbore.

Field tests are ongoing, with applications in Alabama, Oklahoma, and Indonesia. A short test was run in San Ardo field, California, where the tool operated for a period of 6 days in a cyclical steam flood. Production before installation was about 450 barrels of oil per day. Six days of stimulation resulted in a production increase to about 885 barrels per day. Water cut was above 90% in both cases, and even when production nearly doubled, water production did not increase.

Screening criteria include high water cut, high flow, consolidated formations (the harder the better), good production history, 5.5-inch or larger casing, and 440-480 V 3-phase power available. Well temperature needs to be less than 180 F. Formations at depths less than 5,000 feet are preferable.

*For further information, contact Tim Drake, phone: 816-246-0566, email:*tim.drake@sonicproduction.com.

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