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S-CAL RESEARCH CORPORATION

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METHOD FOR CUTTING STEAM HEAT LOSSES
DURING CYCLIC STEAM INJECTION OF WELLS

Contract De-FG49-93CE 15600

SECOND QUARTERLY REPORT

MODIFICATION FOR THE MIDWAY-SUNSET FIELD OF THE SPECIAL CASING JOINT
PREVIOUSLY DESIGNED FOR THE OXNARD FIELD

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ABSTRACT:

The Midway-Sunset Field (CA) is the largest Heavy Oil field in California and steam injection methods have been successfully used for more than 30 years to produce the Heavy Oil from many of its unconsolidated sand reservoirs. In partnership with another DOE/ERIP grantee, our Company has acquired an 80 ac. lease in the SE part of this field, in order to demonstrate our respective technologies in the Monarch sand, of Miocene Age, which is one of the reservoirs targeted by the DOE Class 3 Oil Program.

This reservoir contains a 13 API oil, which has a much higher market value, as a Refinery Feedstock, than the 5 to 8 API Vaca Tar, used only as road paving material. This makes it easier to justify the required investment in a vertical well equipped with two horizontal drainholes. The economic viability of such a project is likely to be enhanced if

Congress approves the export to Japan of a portion of the 27 API (1% Sulfur) AK North Slope oil, which currently is landed in California in preference to lighter and sweeter Far East imported crudes. This is a major cause of the depressed prices for California Heavy Oil in local refineries, which have reduced the economic viability of all EOR methods, including steam injection, in California.

Two proposals, for a Near-Term (3 y.) and for a Mid-Term (6 y.) project respectively, were jointly submitted to the DOE for Field Demonstration of the Partners' new technologies under the DOE Class 3 Oil Program.

The previous design of a special casing joint for the Oxnard field well was reviewed and adapted to the use of existing Downhole Hardware components from three suppliers, instead of one.

The cost of drilling and completion of a well equipped with two horizontal drainholes was re-evaluated for the conditions prevailing in the Midway Sunset field, which are more favorable than in the Oxnard field, leading to considerable reductions in drilling rig time and cost.

Technology Transfer, following a successful Field Test will be much easier in the larger Midway Sunset field, owned by many small Independents and several Major Operators, than in the Oxnard field, owned by only two Independents, one of them with 92% ownership. The previous owner of our Midway-Sunset lease is the West Coast Chairman of a National Industry Organization, the Petroleum Technology Transfer Council (PTTC) and has endorsed our projects. This may speed-up the commercialization of our technologies.

MODIFICATION FOR THE MIDWAY-SUNSET FIELD OF THE SPECIAL CASING JOINT
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BACKGROUND INFORMATION

The Midway-Sunset Field is the largest oilfield in California, with an estimated remaining oil reserve of 256 Million Barrels (DOG, 1990). It includes 10,561 producing wells and more than 3,000 shut-in or abandoned wells. Its reservoirs range from the shallow Tulare, of Pleistocene age, to the Monterey, of Miocene age, at depths reaching 9,000 ft. Most of its remaining oil in the DOE Class 3 Oil Program reservoirs, of Miocene age is of low API gravity (16 -11 API). Its viscosity, ranging from 1,000 to 10,000 cp at reservoir temperature is too high to provide an economic well productivity, at current oil prices, unless it is drastically reduced by steam injection, to a range of 3 to 8 cp at 400 F. For this reason, total oil production by steam injection methods in the Midway-Sunset has steadily increased to about 52 Million Barrel/year over the past 30 years, representing about 88 % of the total field production (59 MMB/D in 1990). The oil production by steam from the Midway-Sunset Miocene reservoirs accounts for 94 % of the total production by steam processes from all of California's Slope Basin Clastic (SBC) reservoirs (Fig.1). From these simple figures, it is clear that any technological improvement in Steam injection processes, which would be successfully demonstrated in the Midway-Sunset field, would have a wide audience and could also find

Figure I

Incremental Oil Recovered from Steam and Cyclic Steam
Processes in California Slope Basin & Basin Clastic Reservoirs

Source: Annual Report of the State Oil & Gas Supervisor California Department of Conservation, Division of Oil & Gas (1970-1991)
OGJ (April 20, 1992) EOR Database

CL & STEAM

applications in smaller fields presenting similar problems.

Steam injection methods already in use in the Midway-Sunset include first Cyclic Steam injection, in which the well tubing is sequentially used to carry steam from the surface to the reservoir and later to lift the heated oil to the surface, by means of a rod pump, which is unseated or pulled out during the steam injection period. The other method is Steamflood, where some wells in a pattern are dedicated to steam injection, while others are only used for oil production.

Response to steam injection is obtained almost immediately with the Cyclic Steam injection method, but its effectiveness steadily declines over successive cycles. On the contrary, in a conventional Steamflood, response to steam is delayed for several years, until the steam front and the resulting oil bank reach the drainage area of the producing wells. To accelerate cash flow, the Cyclic Steam injection is preferable and it may be later converted to Steamflood, when the heated zone of the reservoir, after a sufficient number of cycles, has grown around the wells over some distance, so that the flow of steam from injection wells and the flow of oil into the producing wells are made easier. After steam break-through in the producing wells, the heat stored in the reservoir rock over the steam injection period may be scavenged by switching to water injection. These three modes of operation may be successively used in the same lease to recover up to 80 % of the oil originally in place in the heated zone of the reservoir. Because of imperfect sweep efficiency by steam, by-passed zones remained unheated, especially in heterogeneous reservoirs, so the ultimate oil recovery factor is generally in the

range of 60% only. The main objectives of all improved steam injection processes are:

- 1) to maximize the heating efficiency of the injected steam, by reducing heat losses outside the reservoir,
- 2) to maximize the sweep efficiency of steam, so as to reduce the volume fraction of the reservoir remaining unheated.
- 3) to minimize capital cost and operating expenses per Barrel of oil produced.

These three objectives are also those of the processes to be demonstrated under the two phases of present project

The technology transfer value of such DOE-funded field tests, if economically successful, would be of greater benefit to the Independent Operators of smaller and more marginal leases than to the Majors, who constitute the overwhelming majority of the operators of all existing steam projects, as shown on Table 1. Undoubtedly, the Majors would also make good use of such improvements in their existing projects, which might be expanded as a result, but the CA Independents, who currently cannot afford the use of steam injection methods, would see a greater change in their situation, which, according to a recent API survey, is very dramatic, with nearly two out of three of them currently losing money from their operations.

The Midway-Sunset "Miocene and Other" reservoirs targeted by the DOE Class 3 Oil Program include: a) the Reef Ridge (Lakeview, Sub-Lakeview, Gibson, Potter) of Oligocene age;

b) the Monterey/Stevens (Marvin, Williams, Antelope, Monarch, Hoyt, Webster, Exeter, Moco, Sub-Moco, Obispo, Leutholtz, Metson and Republic) of Miocene age.

They are generally unconsolidated sands of medium to high

Table 1 (continued)

**Slope-Basin & Basin Clastic Reservoir Steam Projects
Within the Midway-Sunset Field by Operator (April, 1992)**

Operator	Pay Zone	Start Date	Area (Acres)	Data		Inc. Oil (BOPD)
				Well Producers	Injector s	
Santa Fe	Potter	85	100	350	45	4,350
Santa Fe	Potter	65	900	880		15,900
Santa Fe	Spellacy	70	400	500		4,000
Santa Fe	Spellacy	91	30	30	8	0
Shell	U. Spellacy	79	70	66	0	1,300
Shell	Lower	89	68	78	10	1,300
Shell	Sub. Hoyt	83	143	205	26	5,700
Shell	Potter	71	400	650	34	12,500
Shell	Monarch	80	85	145	12	4,400
Texaco	Potter	81	77	27	9	1,422
Texaco	Potter	77	27	51	7	565
Texaco	Potter	89	38	62	11	880
Texaco	Potter	91	24	24	6	100
Texaco	Potter	77	36	72	15	1,200
Unocal	Potter	74	81	59	19	614
Unocal	Potter	77	50	79	20	1,550
Unocal	Potter	69	150	165	0	2,000
Total			4,600	6,280	651	130,101

Source: Oil and Gas Journal EOR Database, April 20, 1992.

Note: A total of 5,392 cyclic steam wells and 785 steam drive injectors are listed in the 77th Annual Report of the State Oil and Gas Supervisor

Table 1
Slope-Basin & Basin Clastic Reservoir Steam Projects
Within the Midway-Sunset Field by Operator (April, 1992)

Operator	Pay Zone	Start Date	Area (Acres)	Details		Inc. Oil (BOPD)
				Well Production	Injection	
Arco	Potter	72	8	31	4	880
Arco	Potter	75	108	98	15	3,800
Arco	L. Monarch	83	34	13	2	1,300
Arco	Monarch	81	40	70	10	2,475
Arco	Monarch	72	9	35	4	485
Arco	Sub. Lake	84	15	12	0	105
Arco	Metson	69	50	60	15	1,250
Arco	Potter	72	200	50	3	500
Arco	Potter +			40	1	2,100
Arco	Potter	77	107	210	18	7,000
Arco	Potter	86	40	77	0	750
Arco	Potter +		80	95	11	900
Arco	Potter +		70	59	4	600
Arco	Potter +	90	80	188	5	5,000
Arco	Potter	90	120	247	4	7,000
Arco	Marviz		80	36	4	650
Arco	Potter	86	160	236	80	3,200
Chevron	Potter	78	23	36	5	2,650
Chevron	Monarch	75	84	243	81	9,000
Chevron	Webster	83	84	44	10	2,300
Exxon	Monarch	90		200	100	1,300
Mobil	Monarch	70	400	381	32	8,300
Mobil	Potter	67	140	376	21	10,500

permeability and of fractured shales/diatomite of variable mineralogy. These reservoirs are discontinuous over the 25 miles x 3 miles extent of the field and cut by at least 24 major transverse faults. The Pliocene lies unconformably above these reservoirs, which are truncated or missing in many parts of this elongated field. They all exhibit very rapid changes vertically and horizontally in their properties and thickness, with the typical characteristics of submarine fan-channel complexes, in which vertical continuity is often interrupted by thin discontinuous silt layers acting as permeability barriers.

The heterogeneity of such TORIS-listed reservoirs and the dominating influence of gravity segregation effects for thermal EOR methods in steeply dipping reservoirs make the steam/oil flow paths very tortuous and difficult to predict, so that many portions of the net pay remain unheated and largely unproductive. To maximize steam access, slotted liner-equipped horizontal drainholes have already been successfully used by several Major Operators, in these steeply dipping and anisotropic layers of moderate thickness (≤ 100 ft).

A complicating factor, besides the high viscosity of the oil is the very low energy of these mature reservoirs where the formation pressure is mostly that of the hydrostatic head of the oil column. Artificial lift of the heated oil is required and it is an important consideration in the design of the well completion.

ACQUISITION OF A SUITABLE LEASE

The Field Demonstration of our new technology requires drilling and completion of a new vertical well equipped with twin horizontal drainholes, each with a horizontal reach of about 1,400 ft. in a part of a reservoir which has not yet been subjected to steam injection, and preferably containing vertical producing wells providing a basis for a quantitative comparison with the results obtained with the new well.

A suitable lease of 80 ac. in the SE part of the Midway Sunset was acquired on June 3, 1994, as shown in the attached notarized "Letter of Commitment" signed by the Drilling and Production Co.

An isopach map of the lease, located near the city of Maricopa, CA is shown on Fig. 2, together with a tentative location of the new well and drainholes, with respect to the lease boundaries and the existing vertical wells.

A preliminary structural map shows the Monarch sand to be steeply dipping in a NE direction. The East drainhole is nearly horizontal along the strike of the sand layer, which appears to have been eroded away to the West of that drainhole. If so, this portion of the reservoir is effectively separated from that drained by the West drainhole. Steam injected in the East drainhole will rise and have a tendency to accumulate below this eroded zone, acting as a barrier. Hot oil displaced by the rising steam will be produced first by the East drainhole under cyclic steam injection and, later may reach some of the existing vertical wells along the Eastern boundary of the lease.

The West drainhole, after reaching the horizontal, follows an

DRILLING & PRODUCTION CO.

2323 Border Avenue, Torrance, California 90501
P.O. Box 4120, Torrance, California 90510

Tele: 310/328-2405
Fax: 310/328-2407

LETTER OF COMMITMENT

TO WHOM IT MAY CONCERN:

I, James C. (Chris) Hall, President of Drilling & Production Co. or Torrance California (a California corporation) am the operator of the "Snook & Wells Lease" located near Maricopa, California; furthermore, I certify that I am the direct representative of the leaseholders: Suitcase Sand Co. (a partnership represented by Mr. E. B. Hall) and Hallbergen Co. (a partnership represented by Mrs. Rosemary H. Bergen) who acquired the lease directly from E. B. Hall & Co. (which they owned) when that company was dissolved and the assets were distributed. I hereby declare:

1) That the 80 acres of the Lease in the Midway-Sunset field in Township 11 N., 24 W., Section 12, S 1/2, NE/4 (that area south of Highway 166) near Maricopa, California, with commercially producible Heavy Oil in the Monarch sand of the Monterey/Stevens Formation, of Miocene Age, is operated by our Company and the lease rights are owned by Suitcase Sand Company and Hallbergen & Co, whom I represent.

2) That our Company has negotiated and agreed to signed a separate Agreement with S-Cal Research Corp. of San Rafael, California (a Delaware Corporation) and CLD Technology, Inc. of Ventura, California (a California Corporation) doing business as Dragon Steam Production Company, for the transfer of 80 acres of the "Snook & Wells" Lease, including all wells and facilities, in the event that the DOE accepts their Joint Proposal to Field Test their respective Patented Technologies in said Lease and in said TORIS-listed oil reservoir, under a Contract with the DOE according to the Class III Oil Program (PON No. DE-PS22-94BC14972).

3) That under this Agreement all oil produced from this joint Demonstration Project, including that produced from existing wells currently unproductive, but subject to re-start as a result of the injection of steam and other substances in new wells to be drilled in said lease by this Operating Entity, with partial funding from the DOE, shall belong to said Operating Entity, after payment of royalties and various minority net profits interests.

4) That Reasonable Access is hereby granted to the S-Cal Research Corp. and to Joyce Kostura by our Company to gather information on the characteristics of the reservoir, wells and facilities in said Lease and that our company will make available to them all relevant production history and operating data, for them to plan their future Operations in said Lease.

5) That the current ownership of said Lease by Suitcase Sand Co. and Hallbergen & Co. as lease holders and its operation by Drilling & Production Co. is duly registered by the California Department of Oil and Gas in Bakersfield, to which all operating data are supplied on a monthly basis.

6) That under said Agreement, the Controlling ownership and right to operate said Lease shall be legally transferred to the Operating Entity no later than three months after the Notification of an Award by the DOE to the Joint Proposers (S-Cal Research Corp. and Ms. Joyce Kostura). If no Award is granted to the Joint Proposers, or by December 31, 1994 unless an extension is granted, this Letter of Commitment shall become null and void.

IN WITNESS WHEREOF,

James C. Hall
President, Drilling & Production Co.

/ JUNE 3, 1994
Date

STATE OF CALIFORNIA

COUNTY OF LOS ANGELES) S.S.

On JUNE 03, 1994, before me, MASAYUKI KUWAHARA a notary
Public in and for said County and State, personally appeared

JAMES C. HALL
PRESIDENT, known to me
(or proved to be on the basis of satisfactory evidence) to be the
person whose name(s) is/are subscribed to the within instrument
and acknowledged to me that he/she/they executed the same in
his/her/their authorized capacity(ies), and that by his/her/their
signature(s) on the instrument the person(s), or the entity upon
behalf of which the person(s) acted, executed the instrument.

WITNESS my hand and official seal.

Signature: [Signature]

upwards inclined path along the Western edge of the eroded zone to distribute steam along the lower part of the sand, at some distance above the eroded zone. The rising steam is expected to displace hot oil from the NW part of the lease towards the West drainhole and to revive the vertical wells in the NW part of the lease. Condensed steam and heated formation water may later displace oil above the barrier below the West drainhole, towards the West drainhole.

A detailed study of the reservoir configuration and of its flow characteristics, within the lease, based on raw well data, is included in the proposals submitted to the DOE Class 3 Oil program, as a pre-requisite of the well site selection. This preliminary evaluation, however, based on publically-available maps issued by the CA Division of Oil and Gas provides a sufficient indication that the acquired lease is indeed suitable for a comprehensive Field Test of our technology, yielding a quantitative technical and economic evaluation of any improvements achieved with the new well and drainholes.

REVISED WELL CONFIGURATION

The 10.75" well casing, cemented to a depth of about 950 ft requires a shallower vertical hole than that considered for the Oxnard field (950 ft instead of 1,700 ft) and the uphole section contains no potable water aquifer, so that a 13.375" surface casing is definitely unnecessary. The horizontal length of each drainhole is also limited to less than 1,000 ft. This reduces the thermal stress at the liner/casing joints, so that telescopic liner stubs may safely be omitted. The slanted channels diameter may be increased to 5.25", so that a conventional downhole mudmotor and orientable sub may be used to drill

5" ID drainholes. The drainhole slotted liners are 3.5"OD, equipped with centralizers for more effective gravel-packing and cementing of the 4.5"OD Hydril curved liner uses a conventional Halliburton stage cementing collar (4.6"OD). The larger diameter channels also provides a wider choice of existing downhole hardware components, from three potential suppliers: Baker, Otis and TIW.

Several Major Operators have already drilled horizontal wells in the Midway Sunset and, based on this experience, the local drilling contractors now estimate that drilling and completion operations will only require about 8 days, instead of 25, as previously estimated for the Oxnard field. This illustrates the large cost advantage of a Field Demonstration in the Midway Sunset, over that in the Oxnard field.

The revised conceptual design of the special casing joint is now considered as final and ready for detailed fabrication drawings.

TECHNOLOGY TRANSFER

Following a successful Field Test, the period required for Technology Transfer of the new technology may be shortened, thanks to the cooperation of a National Industry Organization, the Petroleum Technology Transfer Council (PTTC), of which the previous owner of the lease is the Chairman for the West Coast. He has expressed a keen interest in following the progress of our proposed projects and is willing to sponsor our future Technology Transfer efforts, as indicated in the attached letter, addressed to the DOE.

CONCLUSIONS

The acquisition of an 80 ac. lease, suitable for demonstrating our technology in the Midway-Sunset field is an important milestone

towards the commercialization of this patented method and Downhole Hardware.

The formation of a partnership with another DOE/ERIP grantee for the purpose of jointly Field testing our respective technologies and the submission of two joint proposals to the DOE for such projects, under the Class 3 Oil Program is another major step.

The Midway-Sunset selection, instead of the Oxnard field for Field testing results in significant well cost savings Its higher-value oil makes the project economics more attractive.

Future Technology Transfer efforts may be made easier and more effective by the cooperation and sponsorship of the Petroleum Technology Transfer Council (PTTC),

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