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**SIMULATION STUDIES TO EVALUATE THE EFFECT OF FRACTURE CLOSURE ON THE
PERFORMANCE OF NATURALLY FRACTURED RESERVOIRS**

Quarterly Report for the Period
April-June 1991

By
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Work Performed Under Contract No. DE-AC22-90BC14654

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**SIMULATION STUDIES TO EVALUATE THE EFFECT OF
FRACTURE CLOSURE IN THE PERFORMANCE OF
NATURALLY FRACTURED RESERVOIRS**

Progress Report Number 3
July 15, 1991

OBJECTIVES

The study has two principal objectives:

1. To evaluate the effects of fracture closure on the recovery of oil and gas reserves from naturally fractured petroleum or natural gas reservoirs.
2. To evaluate procedures for improving the recovery of these reserves using innovative fluid injection techniques to maintain reservoir pressure and mitigate the impact of fracture closure.

The total scope of the study has been subdivided into three main tasks:

1. Baseline Studies (non-pressure sensitive fractures).
2. Studies with Pressure Sensitive Fractures.
3. Innovative Approaches for Improving Oil Recovery.

The tasks to be performed in the current contract year, the Baseline Studies task, is comprised of the following sub-tasks:

- 1a. Development of Representative Reservoir Conditions.
- 1b. Prediction of Primary Recovery from Vertical Wells.
- 1c. Prediction of Primary Recovery from Horizontal Wells.
- 1d. Prediction of Secondary Recovery from Vertical Wells.
- 1e. Sensitivity Analyses.

SUMMARY OF TECHNICAL PROGRESS

An exhaustive search of the technical literature pertaining to the mechanical and flow behavior of fractured rock systems was carried out. This represented a broadening of the search to include the fields of rock mechanics, hydrology, civil engineering and geophysics as well as petroleum geology and reservoir engineering. The search period was largely limited to 1970 and subsequent years. References to earlier publications were followed up when they appeared to be of interest. Key subjects included:

- fractures
- fracture characterization
- fractured reservoirs
- fractured reservoir simulation
- case histories (fractured reservoirs)
- properties of fractured/jointed rock
 - porosity
 - permeability
 - compressibility
 - relative permeability
 - capillary pressure
 - deformation
 - stress/strain
 - in-situ property determination
- experimental studies of single deformable rock fracture
 - topology
 - flow characteristics
 - mechanical properties
 - friction factor
 - net effective stress

Technical literature indexes were searched for titles suggestive of one or more of the key subjects. Nearly 400 publications were identified as potentially interesting. Abstracts of these were reviewed to eliminate roughly one half of the candidates. The remaining 184 publications were copied and added to the 69 identified by earlier searches of the recent petroleum literature. A more detailed review of all 253 publications was approximately 50% complete at the close of the report period.

A data base of all publications is being prepared to assist in the cross referencing and classification of the copied materials. This will also facilitate bibliography preparation for reporting purposes.

The literature review to date has contributed a wealth of information on fractured reservoir behavior from which it will be possible to select a suitable candidate reservoir for the ongoing study. While no single reservoir has been found with the complete data set needed for simulator initialization, two good candidates

have been identified in the Austin Chalk trend, the Giddings Field and the Pearsall Field. It is highly likely that one of these reservoirs will be chosen. We are currently reviewing the availability of data for each field to determine which has the most comprehensive data set. Assumptions based on experimental studies can be used to fill in the gaps as necessary.

The findings of some of the more interesting experimental data were incorporated in the conceptual model based on the Sixth SPE Comparison Project for dual porosity type simulators. This testing was done to further the validation of the modified program's treatment of permeability in deformable fractures. The deformable fracture aspect of the study is part of the second contract year work scope, nonetheless, the validation of this aspect of the revised program code was considered important enough to be carried out in the current contract year.

A revised milestone schedule, reflecting the current status of the project and the revised plan for the current fiscal year is attached. We have added manpower to the project which we believe will allow us to complete the current fiscal year tasks during the final quarter.

U.S. DEPARTMENT OF ENERGY
MILESTONE SCHEDULE PLAN & STATUS REPORT

FORM APPROVED
OMB NO. 1901-1400

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1. TITLE		2. REPORTING PERIOD												3. IDENTIFICATION NUMBER			
Simulation Studies to Evaluate the Effect of Fracture Closure		1990-1991												DE-AC22-90BC14654			
4. PARTICIPANT NAME AND ADDRESS														5. START DATE			
K&A Energy Consultants, Inc. 6849 East 13th Street Tulsa, OK 74112														October 1, 1990			
7. ELEMENT CODE		8. DURATION 1990-1991												6. COMPLETION DATE			
		O	N	D	J	F	M	A	M	J	J	A	S	September 30, 1993			
TASK 1														10 PER. CENT COMPLETE			
														a. Plan			
														b. Actual			
	Baseline Studies																
	1a.	Representative Reservoir Conditions												100	50		
	1b.	Primary Recovery Performance from Vertical Wells												100	0		
	1c.	Primary Recovery Performance from Horizontal Wells												100	0		
	1d.	Secondary Recovery from Vertical Wells												0	0		
	1e.	Sensitivity Analysis												0			
		<input checked="" type="checkbox"/> Quarterly Report <input checked="" type="checkbox"/> Annual Report															

11. SIGNATURE OF PARTICIPANT'S PROJECT MANAGER AND DATE

END

**DATE
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