KINETICS OF UNDERGROUND COMBUSTION

Progress Report

for Period September 1, 1974 - June 1, 1976

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KINETICS OF UNDERGROUND COMBUSTION

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ABSTRACT

The first phase of the underground combustion study is essentially nearing completion. Under the sponsorship of ERDA a modern, high pressure fire flooding research facility has been installed in our laboratory. This equipment, primarily a gift from the Sun Oil Company, is valued at over \$100,000. Significant renovations and modification repairs have been made to make it fully operational; and with the aid of Sun Oil's personnel as consultants a successful test run has been performed.

During the remaining three months of the contract a set of approximately 10 runs will be made to test the operation of the unit at different pressures and with different oil-sand charges. Operating techniques will be perfected and an operating manual prepared.

During the next year we plan to make some modification in the equipment to allow a moving probe to continuously sample products from a given point in the moving front. With this modification many tests will be performed yielding chemical reaction rate data for both the decomposition and burning reactions.

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Beginning in September, 1974 the project involved preliminary design studies with the purpose of constructing a combustion tube for studying reaction rates in underground combustion.

During this first quarter, Mr. Paul Buthod, the co-investigator, Dr. G. W. Thomas, the principal investigator and Mr. V. Bangia, a Ph. D. candidate working on the project, visited the USBM Research Station in Morgantown, West Virginia. The purpose of this visit was to review their work on underground coal gasification and exchange views in those areas where these two projects interface.

In the course of planning the design for the entire apparatus it soon became apparent that our equipment needs exceeded our budget limitations. Consequently, we approached Sun Oil Company for additional equipment. Their response to our appeal was favourable. Accordingly, they have contributed their entire in situ combustion tube test facility to the Department of Petroleum Engineering. This facility has been appraised at a value of \$103,580.

The facility consists of thin-walled combustion tubes, external heating facilities, a large pressure vessel, instruments for controlling and measuring temperatures at 52 thermocouple stations, meters for measuring inlet and outlet rates, gas scrubbers, a gas chromatograph with associated recording equipment, and a number of vessels and peripheral equipment necessary to monitoring the progress of a combustion test. In addition, the donation includes consulting help on an as-needed basis by members of Sun's staff for approximately one year.

During the second quarter, we transported this equipment from Dallas to Tulsa and began installing it in one of our laboratories.

A visit to the underground coal gasification project at Hanna, Wyoming was made by Mr. Paul Buthod, (co-investigator) and Dr. G. W. Thomas (principal investigator) and Mr. Omar Allag (graduate student) in early June, 1975. We saw the field test and also visited with personnel at the Laramie station to review their overall research program involving

underground heating in coal and oil shale.

A progress report was presented to the "ERDA Symposium on Enhanced Oil and Gas Recovery" in Tulsa September 4 and 5, 1975. A research report was also included in the ERDA Annual Report in December, 1975.

The third quarter was spent in installing the Sun Oil Company equipment. Several visits were made by the Sun personnel who worked with Mr. Omar Allag in eliminating bugs and replacing bad parts. Among the parts that needed repair were the following:

The electric power wiring had to be replaced.

The plastic and copper tubing connections were replaced.

Most of the diodes in the scanner were burned out and have been replaced.

The gas chromatography unit needed overhauling.

Several thermocouples in the reactor needed to be replaced.

Several of the temperature control units needed new electronic parts and readjustment.

Several leaky hand control valves were replaced.

A scheme for accurate weighing of the charge was developed.

Small leaks were repaired and the whole system tested at 600 psig.

This work has been completed and a test run has been made on a charge composed of the following:

Sand	45.	pounds
Clay	2.5	pounds
Oil (28.0 A.P.I. Crude)	5.9	pounds
Water	2.0	pounds

The test run was performed by Mr. Omar Allag, graduate assistant on the project, and was witnessed by Mr. Joe Parmley and Mr. Clarence Braun consultants or advisors sent from the Sun Oil Company laboratories in Dallas. The operating pressure was 120 psig and a representative temperature profile of the burning for 3 hours is shown in Figure 2. The run lasted for 5 hours and all the equipment performed satisfactorily except for three thermocouples which must be re-positioned. The whole charge was not burned on this first run and no material balance was attempted.

We plan to make approximately ten complete runs during the remaining three months of the contract. The first set will be with the 28. API crude oil, checking material balances, air flow rates, pressure, oil-water saturation for the runs and operating at several system

pressures. The remaining runs will be on a lower gravity oil sample at varying pressures and oil saturations. In all of these runs gas analysis showing N_2 , O_2 , CO_2 , H_2 , methane, ethane, etc. will be reported at even time intervals during the burn.

An attempt will be made, of course, to compare results obtained in these runs with previous tests of Sun Oil and also with the published literature.

Figure 2 . TEMPERATURE PROFILE IN REACTOR AFTER 4 HOURS