PUBLICATIONS LIST 28

Bartlesville Energy Technology Center
Edward J. Lievens, Jr., *Acting Director*

DOE/BETC/SP-83/5
January 1983

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With the exception of this publications list and the three quarterly research publications, Liquid Fossil Fuel Technology, Enhanced Oil Recovery and Improved Drilling Technology, *and* Western Gas Sands Project Status Report, *the Bartlesville Energy Technology Center no longer automatically distributes technical reports and publications to mailing lists. You must now select the reports of interest to you and make specific application for them. Reports will be furnished free as long as the supply lasts, but only one copy of any report and a maximum of 10 titles per order can be furnished. Please request only those publications needed, order by the report number listed at the beginning of each citation, and enclose a self-addressed mailing label.*

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GENERAL RESEARCH

Quarterly Reports

DOE/BETC/QPR-82/3. **Liquid Fossil Fuel Technology.** Quarter ending September 30, 1982. Edited by Bill Linville. January 1983. 76 pp. Progress reports on research projects conducted by Bartlesville Energy Technology Center personnel and contractors are given, with emphasis on liquid fossil fuel projects. Reports are included from BETC's Divisions of Extraction Research, Processing and Thermodynamics Research, Utilization Research, and Project Integration and Technology Transfer. Free subscription available upon request.

EXTRACTION

Enhanced Oil Recovery—General

DOE/BETC-82/4. **Contracts for Field Projects and Supporting Research on Enhanced Oil Recovery and Improved Drilling Technology.** Progress Review No. 32, Quarter ending September 30, 1982. Edited by Bill Linville. January 1983. 116 pp. Status reports are given of various enhanced oil and gas recovery projects sponsored by the Department of Energy. The field tests and supporting research on enhanced oil recovery include chemical flooding, carbon dioxide injection, thermal/heavy oil recovery, microbial recovery, and residual oil determination. Other research includes resource assessment, extraction research, improved drilling methods, environmental technology, and oil recovery by gravity mining. Free subscription available upon request.

DOE/ET/14010-1. **Enhanced Oil Recovery in the Gulf of Mexico.** Lewin and Associates. January 1983. 422 pp. This project was designed to identify reservoirs in the Gulf that are geologically, technologically, and economically amenable to enhanced oil recovery (EOR). Reservoirs containing 56 percent of the Gulf's oil-in-place were studied individually. A subset of reservoirs, accounting for about 20 percent of the overall resource, was assessed in detail using engineering and economic models. The results indicate that the EOR potential could be up to 4.4 billion barrels in known reservoirs. Technological performance could have a great effect on the EOR potential, especially the ability to recover oil from zones of the reservoirs previously unswept by conventional operations. The rapid decline of many fields in the Gulf will lead to the abandonment and removal of platforms, which would economically prevent recovery of substantial portions of the EOR potential. Therefore, collaboration by industry and government research and development agencies is needed to realize the offshore Gulf potential.

Enhanced Oil Recovery—Chemical

DOE/BC/10082-12. **Adsorption from Flooding Solutions in Porous Media—A Study of Interactions of Surfactants and Polymers with Reservoir Minerals, Third Annual Report.** Columbia University. January 1983. 228 pp. Loss of surfactants by adsorption and related processes is a complex phenomenon dependent upon many system parameters. In order to develop a full understanding of the phenomena involved, tests were conducted with well characterized systems of increasing complexity. Initial tests involved adsorption of isomerically pure sulfonates on alumina. Subsequently, clay, oil, and alcohol were gradually incorporated into the study. Studies also have been initiated with problem minerals such as gypsum and limestone under high temperature and salinity conditions.

DOE/ET/10145-74. **Data Requirements for EOR Surfactant-Polymer Process Simulation and Analysis of El Dorado Pilot Project Simulation, Butler County, Kansas, Volume I: Technical Report, Volume II: Appendices.** Gulf Universities Research Consortium. January 1983. Vol. I: 66 pp. Vol. II: 246 pp. The results of computer simulation of the El Dorado pilot project indicated that conventional data from the project and other data in the public domain were not adequate for geologic, reservoir, and process characterizations in a complex numerical simulation. Based upon this study, a comprehensive body of data requirements for EOR simulation is defined in detail. Geologic characterization includes descriptors for rock, interwell, and intrasystem correlations; reservoir characterization includes descriptors for fluid/rock, production, and flow rate properties; process characterization includes descriptors for chemical properties, interactions, and functions. The appendices include a flow chart for surfactant-polymer process simulation and reports describing the CFTE simulator program used in this study.

Enhanced Oil Recovery—Thermal

DOE/ET/12056-28. Comprehensive Analysis of the Carbon/Oxygen Log. Stanford University Petroleum Research Institute. January 1983. 76 pp. This report reviews the current interpretation methods and presents a cross-plotting technique to compute hydrocarbon saturation for induced gamma ray spectroscopy logs. The technique assumes that each reservoir component has a specific ratio of elemental ratios, and the total log response is a linear function of each ratio in the matrix, the hydrocarbon, the formation water, and the shale. The technique has three unknowns: porosity and volumetric fraction of shale (obtained from a standard set of open hole logs) and oil saturation, which is computed from a linear equation that approximates the bulk carbon-to-oxygen response. The equation contains four terms representing both matrix and fluid responses in the reservoir. An example of the empirical cross-plotting approach is given of an observation well of a steam-foam pilot in Kern County, Calif.

Western Gas Sands

DOE/NV/10249-4. Western Gas Sands Project Status Report, April–June 1982. CER Corp. January 1983. 102 pp. This report summarizes the quarterly progress of government-sponsored projects to increase gas production from low permeability gas sands of the Western United States. CER Corp. is investigating downhole shut-off to develop a shut-off tool. The University of Oklahoma completed the two-dimensional lenticular well simulator model consisting of the necessary mathematical equations to simulate reservoir fracture and well performance under a variety of specified conditions. Lawrence Livermore National Laboratories completed a two-dimensional crack model, and work has begun on developing a pseudo three-dimensional crack model. Preparations have begun at Los Alamos National Laboratory to test the 6-inch permanent magnet pre-prototype tool; at Sandia National Laboratories, an analytical version of the Surface Electric Potential mathematical model was completed. For the Multi-Well Experiment program, researchers completed cased hole logging, directional surveys, and two geophysical surveys. The data provided by DOE Well Test Facility's drill stem test of MWX-1 indicated wellbore storage was predominant during the buildup period of the test and essentially masks the pressure transient normally used in the analysis. Free subscription available upon request.

PROCESSING AND THERMODYNAMICS

Processing

DOE/BC/10562-5. Used Lubricating Oil Re-Refining Demonstration Plant Data Acquisition, Topical Report I: Environmental Considerations. Booth Oil Co. January 1983. 116 pp. In 1978, Booth Oil decided to design and build a new re-refining facility. This report describes the environmental laws, regulations, and other considerations that were addressed. It details the work performed in assessing the theoretical and actual air emissions from the facility and describes the plant's wastewater treatment system.

Date Published—February 1983

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PUBLICATIONS LIST 29

Bartlesville Energy Technology Center
Gordon W. Dean, *Acting Director*

DOE/BETC/SP-83/8
February–March 1983

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GENERAL RESEARCH

Special Publications

DOE/BETC/SP-83/7. **List of BETC Publications.** BETC staff. March 1983. 28 pp. This report is a compilation of the 1982 BETC publications lists and includes abstracts of all reports published by BETC from January through December 1982.

EXTRACTION

Enhanced Oil Recovery—General

DOE/BC/10115-2. **Oilfield Water Analyses Data Bank.** University of Oklahoma. February 1983. 26 pp. This report describes the work performed in collecting, evaluating, and computerizing oilfield water analyses for the Oilfield Water Analyses Data Bank. The computer file containing these analyses is known as the BRIN file. The file currently contains 77,650 analyses obtained by contacts with industry sources, state and federal agencies, and publication searches. Each listing gives the API well number, well classification, depth from which the sample was taken, lithology of the well, name of producing formation, porosity and permeability of pay zone, bottom hole pressure, and any additional information available.

DOE/PC/30259-1. **An Evaluation of Heavy Oil Mining, Final Report, Volumes 1 and 2.** Energy Development Consultants/Stone & Webster Engineering Corp. March 1983. Vol. 1: 266 pp. Vol. 2: 316 pp. Oil mining is one technology that shows promise for recovery of heavy oil from U.S. resources unrecoverable by conventional production methods. Three mining techniques—surface extractive mining, underground extractive mining, and mining for access—were studied for their technical, environmental, and economic feasibility for heavy oil recovery. The study was divided into three areas: (1) evaluation of heavy oil resources amenable to mining based on DOE screening criteria, (2) evaluation of various mining technologies to select those most promising for heavy oil recovery, and (3) study of specific sites for development of preliminary mining concepts and economics.

DOE/SF/11564-1. **Analysis of Unit Mobility Ratio Well-to-Well Tracer Flow to Determine Reservoir Heterogeneity.** Stanford University Petroleum Research Institute. February 1983. 198 pp. Exact analytic equations were derived to define breakthrough curves for different developed flooding well patterns for unit mobility ratio. Breakthrough areal sweep efficiencies at various mobility ratios were shown to be nearly independent of mobility ratios, while the post breakthrough data were different for each mobility ratio. The study also investigated flow of a tracer slug in various patterns. The results show that the effluent tracer concentration depends upon the pattern geometry and size and the dispersion constant of the formation. A computer program was developed based on a non-linear optimization technique that decomposes a detected tracer breakthrough profile from a multilayered system into responses from individual layers. A five-spot field example that was successfully decomposed into several layers is shown to illustrate the use of this research.

Enhanced Oil Recovery—Chemical

DOE/BC/10033-6. **Evaluation of the North Stanley Polymer Demonstration Project.** Keplinger and Associates. February 1983. 38 pp. The objective of the cost-shared project was to evaluate the technical efficiency and economic feasibility of polymer-enhanced waterflooding in a sandstone reservoir that has been waterflooded successfully and is approaching the economic limits of waterflooding. The ultimate incremental oil recovery from the polymer flood was estimated to be about 570,000 bbl (or about 1.4 percent of the original oil-in-place), significantly less than original recovery predictions. The lower-than-anticipated recovery is attributed principally to the extremely heterogeneous nature of the reservoir.

Enhanced Oil Recovery—Thermal

DOE/SF/10762-3. **Field Demonstration of the Conventional Steam Drive Process with Ancillary Materials.** Chemical Oil Recovery Co. March 1983. 212 pp. The most important factors observed regarding the steam foam treated wells in this study were the use of injection profiles, chemical tracers, and production data to show that the creation of an *in situ* foaming agent in a steam drive

alters the flow path of the injected steam. Steam diversion created improved sweep efficiency in each of the four treated patterns; however, only two showed improved oil production rates. This indicates that steam must be diverted into areas of the reservoir higher in oil saturation to augment production.

Enhanced Oil Recovery—Microbial

CONF-8205140. Proceedings of 1982 International Conference on Microbial Enhancement of Oil Recovery. Edited by E. C. Donaldson and J. B. Clark. February 1983. 224 pp. An International Conference on Microbial Enhancement of Oil Recovery (MEOR) was held May 16–21, 1982, at Afton, Okla., and was sponsored by the U.S. Department of Energy, the University of Oklahoma Energy Resources Center, and the Engineering Foundation. More than 140 microbiologists and engineers from around the world attended to discuss the development of methods for the application of microbial systems to the petroleum industry. This proceedings contains papers presented at the conference in the following areas: microbes and their metabolites, transport of bacteria in porous geological materials, application to heavy oils, and MEOR field applications.

Western Gas Sands

DOE/BC/10498-5. Sonic and Electrical Properties of Partially Saturated Tight Gas Sands, Final Report. Stanford University. March 1983. 60 pp. This study was aimed at relating the seismic and the electrical properties of tight gas rocks to their pore space geometry, permeability, and level of water saturation. Results of laboratory experiments of wave propagation in Cotton Valley and Spirit River sandstones as a function of partial water saturation and wave frequency showed that wave velocities and the velocity ratio are sensitive to the presence of gas. Furthermore, wave attenuation is sensitive to the amount of gas in the pore space. Ultrasonic measurements in tight gas sands tend to yield higher velocity values due to the inability of the pore fluid pressure to homogenize during the passage of waves. Laboratory measurements were made of the complex electrical response of selected tight rocks and compared with normal permeability Berea sandstone. The results show that the dielectric property of tight gas sands is very sensitive to partial water saturation and may give insight into the nature of the pore space and provide a practical measure of *in situ* water saturation.

PROCESSING AND THERMODYNAMICS

Characterization

DOE/BETC/PPS-83/1. Motor Gasolines, Summer 1982. E. M. Shelton. March 1983. 72 pp. The analytical data for 796 samples of motor gasoline were submitted to BETC for study, calculation, and compilation under a cooperative agreement with the American Petroleum Institute. The samples were collected from service stations throughout the country and analyzed in the laboratories of various refiners, motor manufacturers, and chemical companies. The data are tabulated by groups according to grades for 17 marketing districts in the United States. A map shows marketing areas, districts, and sampling locations. Also included are charts indicating the trends of selected properties of motor fuels since 1959 and octane distribution percentage charts for the country.

DOE/BETC/PPS-83/2. Aviation Turbine Fuels, 1982. By E. M. Shelton and C. L. Dickson. March 1983. 11 pp. Properties of some aviation turbine (jet) fuels marketed in the United States during 1982 are presented in this report. The samples represented are typical 1982 production and were analyzed in the laboratories of 14 manufacturers of aviation turbine fuels. The data were submitted for study, calculation, and compilation under a cooperative agreement between BETC and the American Petroleum Institute. Results for the properties for 90 fuel samples are included for military grades JP-4 and JP-5 and commercial type Jet A.

DOE/BETC/RI-82/3. Computer Processing of Mass Spectral Data. Part V. Assignment of Formulas to Experimental Masses. Representative Databases for Program FZM. K. C. Chung, C. S. Hwang, and S. E. Scheppele. February 1983. 522 pp. This report describes a versatile and highly efficient computer method for processing experimental masses. Program FZM assigns formulas to masses using data bases generated by program DBG. Each data base consists of formula codes and fractional Kendrick masses grouped into 14 nominal-mass Z series tables. The formula codes in each table are arranged in order of decreasing fractional mass. In order to verify correct implementation of programs DBG and FZM and to allow manual application of the formula-assignment process, a data base is reproduced for each homologous unit.

UTILIZATION

Adaptive Engineering

DOE/BC/10362-10. Evaluation of Improved Materials for Stationary Diesel Engines Operating on Residual and Coal-Based Fuels, Final Report. Advanced Mechanical Technology, Inc. March 1983. 96 pp. This study evaluated ceramic coatings and monolithic ceramics that could be incorporated into the design of stationary piston engines to allow: (1) the use of fuels that contain more corrosive and abrasive contaminants than current standards allow, (2) operation at higher mean effective pressure to increase the efficiency and reduce the size of the engine, and (3) reduction in wear of critical components to increase the engine's service life. Recognizing the complexity of the study of friction and wear in a reciprocating engine, the report includes the identification and characterization of potential materials that might be incorporated into existing engine designs. The materials were screened with simple laboratory equipment designed for this purpose, and scanning electron microscope analysis was performed on wear surfaces. An accelerated wear test was also developed using a single-cylinder diesel engine burning a coal-oil mixture.

Alternate Fuels

Note: *The following three reports all give results of 500-hour engine durability tests to evaluate the effects of using 160-proof ethanol to supplement diesel fuel in three different diesel engines. In all cases, the ethanol was sprayed into the intake manifold of the engine at a rate equal to 25 percent of the total fuel flow. Performance testing for power and emissions and pre- and post-inspections of critical components of the engine confirmed that no significant changes occurred to the engine due to the alcohol fueling. Researchers concluded that alcohol fumigation, performed under the conditions of this test, does not result in serious wear or durability penalties.*

DOE/BC/10467-11. Effect of Low-Proof Alcohol Utilization to Supplement Diesel Fuel on Engine Life Expectancy, John Deere 6466T, Final Report. Southwest Research Institute. March 1983. 30 pp. Test results for a 157-horsepower John Deere diesel engine.

DOE/BC/10467-12. Effect of Low-Proof Alcohol Utilization to Supplement Diesel Fuel on Engine Life Expectancy, Caterpillar 3306 PCI, Final Report. Southwest Research Institute. March 1983. 32 pp. Test results for a 187-horsepower Caterpillar diesel engine.

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PUBLICATIONS LIST 30

Bartlesville Energy Technology Center
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DOE/BETC/SP-83/11
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EXTRACTION

Enhanced Oil Recovery—General

DOE/BC/10412-40. Assessment of Water Issues Associated with Enhanced Oil Recovery: A User's Guide. Gulf Universities Research Consortium. April 1983. 200 pp. This user's manual is designed to provide ready reference and to assist EOR producers, energy planners, and decision-makers in assessing the impacts of water issues related to EOR production. An evaluation is made of EOR water requirements, using publicly available information, data from actual field applications, and information provided by EOR technologists. Water quantity and quality requirements representing the total water needed from all sources are estimated for individual EOR processes in states and specific locations where the processes likely will play major roles by the year 2000. Information about regulatory bodies responsible for water supply control and use is presented in tabular form by states.

DOE/BETC-83/1. Contracts for Field Projects and Supporting Research on Enhanced Oil Recovery and Improved Drilling Technology. Progress Review No. 33, Quarter ending December 31, 1982. Edited by Bill Linville. April 1983. 104 pp. Status reports are given of various enhanced oil and gas recovery projects sponsored by the Department of Energy. The field tests and supporting research on enhanced oil recovery include chemical flooding, carbon dioxide injection, thermal/heavy oil recovery, microbial recovery, and residual oil determination. Other research includes resource assessment, extraction research, improved drilling methods, environmental technology, and oil recovery by gravity mining. Free subscription available upon request.

DOE/BETC/IC-83/1. Abandoned Oil Fields in Alabama, Florida, Illinois, Indiana, Kentucky, Michigan, Missouri, New York, Tennessee, and West Virginia. U.S. Department of Energy. April 1983. 230 pp. A considerable amount of petroleum may be economically recoverable at oil prices in effect now or in the future from reservoirs abandoned when prevailing prices were lower. A major barrier to renewed production from these abandoned fields has been the lack of pertinent, readily available, systemized information for oil producers. The DOE developed this listing from the Petroleum Data System at the University of Oklahoma and by information from state agencies; this list includes about 240 abandoned oil fields.

DOE/BETC/IC-83/2. Abandoned Oil Fields in Alaska, California, Colorado, Montana, North Dakota, Utah, and Wyoming. U.S. Department of Energy. April 1983. 136 pp. This list includes production data from about 250 abandoned oil fields.

Enhanced Oil Recovery—Chemical

DOE/BC/10033-7. Evaluation of the Coalinga Polymer Demonstration Project. Keplinger and Associates, Inc. April 1983. 24 pp. The Coalinga polymer demonstration project was designed by Shell Oil Co. to show the relative merits of water and polymer flooding in a reservoir with medium viscosity oil. Located in the East Coalinga Field, Fresno County, Calif., the 149-acre project area contained four 22-acre inverted five-spot injection patterns. The target reservoir was a 350 ft, unconsolidated sandstone formation at a depth of 2,000 ft. Following nearly 2 years of water injection and an extensive field polymer injectivity and filtration study, polymer injection into four injection wells began in May 1978. The production response to polymer injection was less than expected, and the project was terminated early. Two factors contributing to the poor performance were a loss of polymer injectivity and a lack of moveable oil in the project area.

DOE/BC/20001-11. Tertiary Oil Recovery Processes Research at the University of Texas, Final Report. University of Texas. April 1983. 174 pp. In the first area of study,

surfactant design and evaluation, testing was performed on branched alkyl benzene sulfonates, secondary alkane sulfonates, and α-olefin and ethoxylated alkane sulfonates. As part of a surfactant adsorption project, researchers investigated: (1) the influence of alcohol cosolvents on the adsorption of sodium laurate on powders, (2) adsorption from microemulsions, (3) monomer/micellar equilibrium by ultrafiltration, and (4) measured adsorption from excess aqueous phases.

Enhanced Oil Recovery—Thermal

DOE/BETC/RI-83/2. Laboratory Experiments Simulating Fire Flooding Through a Fractured Reservoir. J. S. Miller and R. Jones. April 1983. 88 pp. Experiments were performed to determine the technical feasibility of recovering heavy oil by the *in situ* combustion process from shallow reservoirs that contain no reservoir energy. The results of tests performed with cores from a heavy oil reservoir near Bartlett, Kans., showed that 78 percent of the oil was recovered from whole cores as a result of the *in situ* combustion process, while 16 percent was used as fuel for combustion. Tests on fractured cores showed that 33 percent of the oil was recovered from the cores as a result of combustion, while 45 percent was used as fuel. Tests on fractured cores held apart by propping agents showed that 16 percent of the oil was recovered from the cores as a result of combustion, while 38 percent was used as fuel.

DOE/BETC/RI-83/3. *In Situ* Combustion Project at Bartlett, Kansas, Final Report. J. S. Miller and K. L. Spence. April 1983. 56 pp. BETC personnel are developing petroleum recovery techniques for shallow, low-productivity, heavy oil deposits in southeastern Kansas, southwestern Missouri, and northeastern Oklahoma. As part of this work, an *in situ* combustion experiment was conducted on the Link Lease in Labette County, near Bartlett, Kans. Two attempts to ignite the formation are described. The well completion methods, hydraulic fracturing, air injection, workovers, production techniques, and well-monitoring methods are described. The progression of the burn and the final extent of the burn front were evaluated by the following methods: (1) controlled source audio-frequency magnetotelluric technique (CSAMT), (2) thermogravimetric analysis (TGA), (3) burn-front model, (4) geophysical log analysis, and (5) computer model study.

DOE/ET/12059-5. The "200" Sand Steamflood Demonstration Project, Fifth Annual Report, June 1980–June 1981. Santa Fe Energy Co.—Western Division. April 1983. 40 pp. An enhanced steamflooding test was initiated in the Midway-Sunset Field, Kern County, Calif., in July 1975 to demonstrate the operational, recovery, and economic aspects of steamflooding a typical heavy oil reservoir that showed poor response to cyclic steam stimulation. The "200" Sand Reservoir contained approximately 50 million bbl of oil-in-place. After a pilot test consisting of four 2.35-acre inverted seven-spot steam drive patterns showed good response, the project was expanded to a full-scale steamflood test by drilling and completing 30 producing wells and 10 steam injection wells.

Enhanced Oil Recovery—Carbon Dioxide

DOE/BETC/RI-83/1. Economics and Analysis of the Miscible CO_2 Injection Project, Granny's Creek Field, West Virginia. R. V. Smith, R. J. Watts, and F. W. Burtch. April 1983. 40 pp. A tertiary oil recovery pilot in the Granny's Creek Field was begun in 1976 as a cooperative project between DOE and Columbia Gas Transmission Corp. Carbon dioxide was injected into the Pocono Big Injun sand as a liquid, and the pilot portion of the reservoir was maintained at or above miscible pressure. The resulting additional oil recovery was 8,681 bbl for 19.76 million pounds of injected CO_2. After injection was stopped, production of additional oil decreased sharply, indicating there were no benefits for an extended period of time from CO_2 injection.

DOE/MC/19393-1323. Estimates of Incremental Oil Recoverable by Carbon Dioxide Flooding and Related Carbon Dioxide Supply Requirements for Flooding Major Carbonate Reservoirs in the Permian, Williston, and Other Rocky Mountain Basins. Gruy Petroleum Technology, Inc. December 1982. 98 pp. Oil production and carbon dioxide supply requirement estimates were made based on calculations for 279 reservoirs. Most of the reservoirs (188) are in the Permian Basin of Texas and New Mexico. Of the remainder, 68 are in the Williston Basin of Montana, North Dakota, and South Dakota, and 23 others are scattered throughout several smaller Rocky Mountain basins. Based on estimates derived using a volumetric model described in the report, the following amounts of incremental oil are capable of being produced by carbon dioxide flooding of carbonate reservoirs: Permian Basin, 10.5 billion bbl; Williston basin, 0.76 billion bbl; and various Rocky Mountain basins, 0.49 billion bbl.

Western Gas Sands

DOE/BC/10038-27. Lightweight Proppants for Deep Gas Well Stimulation, Third Annual Report, July 1, 1981–June 30, 1982. Terra Tek, Inc. April 1983. 114 pp. The need exists for lower-density, less-expensive proppants for use in hydraulic fracturing treatments. Ceramics are the best materials for obtaining economical proppants with adequate strength. Techniques are described for fabricating solid porcelain proppants and hollow ceramic proppants. Several of the proppants evaluated have potential for most hydraulic fracturing jobs and are less expensive than bauxite.

DOE/BC/10215-23. Numerical Modeling of Massive Hydraulic Fractures, First Annual Report, September 1980–August 1981. Oral Roberts University. April 1983. 72 pp. Models of three-dimensional fracture propagation are being developed to study the effects of variations of stress and rock properties on fracture shape and bottomhole pressure. Using quasi-static models, it was found that variations in fracture toughness have at least as great an effect on the fracture as variations in stress contrast. Viscous fluid flow effects were considered in two different models. A parametric study was conducted on effects of stress contrast, fracture toughness, and Young's modulus on fracture shape and bottomhole pressure. One flow model, representing the vertical stress variation, showed the onset of a rapid growth in fracture height as stress contrast was reduced. When the stress contrast is too low, or if a fracture breaks through a containing zone, the fracture length/height ratio may be so low that both a better width equation and a better flow equation need to be incorporated into the model.

PROCESSING AND THERMODYNAMICS

Processing

DOE/BC/10332-1. Hydrotreating for Re-refined Lubricating Oil, Final Report. New Mexico State University. April 1983. 92 pp. Eight commercial hydrotreating catalysts were screened for used lubricating oil hydrotreating. The catalysts were tested at temperatures from 550 to 750°F and at pressures of 500 to 700 psig. Using color change and viscosity as the measure of performance, two catalysts—American Cyanamide HDS-20A and Harshaw HT-500—were selected for trickle-bed experiments. Initial examination of the catalysts after these tests showed residual hydrocarbons on the surface. Washing with acetone removed substantially all this residual material. Elemental analysis of the remaining material showed carbon.

DOE/ET/12385-1. Effects of Enhanced Oil Recovery Chemicals on Crude Refining, Final Report. UOP, Inc. April 1983. 120 pp. This study evaluated the refining processi-

bility of crude oils produced during enhanced oil recovery operations using chemical flooding techniques. After crude oils and chemicals were acquired from field tests, preparative distillations were made of virgin and EOR crude oils, and fractions were analyzed for surfactant and initial processing studies. The results indicate that: (1) preparative distillation of crude oils containing surfactants produced various effects, depending on the structure of the surfactant and the nature of the crude oil, (2) the activity of a catalyst was reduced when a vacuum resid fraction with a sodium-containing surfactant was processed, and (3) solvent extraction of surfactant-containing vacuum resids produced an oil and pitch comparable in quality to those produced by extraction of virgin resids.

COOPERATIVE RESEARCH

Note: *The following reports give results of work performed under the agreement between Venezuela and the United States to cooperate in energy research.*

Fossil Energy I-1. DOE/BETC/SP-83/12 **Supporting Technology for Enhanced Oil Recovery—Characterization of Heavy Crude Oils.** Republic of Venezuela Ministry of Energy and Mines and U.S. Department of Energy. April 1983. 42 pp. Annex I: Joint Characterization of Heavy Crude Oils. The goals of the work described in this report were to: (1) determine data needed for developing correlations for processing heavy oils, and (2) develop new or modified analytical techniques to acquire these data. Studies examined both the lower boiling range materials with currently known techniques and higher boiling range materials with methods developed by this joint effort.

Fossil Energy III-1. DOE/BETC/SP-83/14 **Enhanced Oil Recovery—Evaluation of EOR Projects.** Republic of Venezuela Ministry of Energy and Mines and U.S. Department of Energy. April 1983. 60 pp. Annex III: Evaluate Past and Ongoing Enhanced Oil Recovery Projects. The report emphasizes the need for methods and techniques to assist oil producers in making decisions to implement EOR projects. Discussions include data analysis and data base compilation for use in improving predictive model accuracy.

Fossil Energy IV-1. DOE/BETC/SP-83/15 **Enhanced Oil Recovery—EOR Thermal Processes.** Republic of Venezuela Ministry of Energy and Mines and U.S. Department of Energy. April 1983. 474 pp. Annex IV: EOR Thermal Processes. Discussions are presented in the areas of thermal protection systems, instrumentation and control, and deep reservoir steam injection technology.

Fossil Energy V-1. DOE/BETC/SP-83/16 **Supporting Technology for Enhanced Oil Recovery—Drilling, Coring, and Telemetry.** Republic of Venezuela Ministry of Energy and Mines and U.S. Department of Energy. April 1983. 136 pp. Annex V: Drilling, Coring, and Telemetry as Supporting Technology for Enhanced Oil Recovery Projects. The report addresses technology development in these areas in order to reduce drilling costs and provide better reservoir information to improve the economic viability of EOR projects.

Fossil Energy VI-1. DOE/BETC/SP-83/17 **Enhanced Oil Recovery—Residual Oil Saturation.** Republic of Venezuela Ministry of Energy and Mines and U.S. Department of Energy. April 1983. 40 pp. Annex VI: Residual Oil Saturation (ROS). This report details the exchange of technical literature and bibliographic listings, reciprocal visits to laboratories and field sites where ROS measurements are in progress, and discussions about future cooperative research and development.

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DOE/BETC/SP-83/21
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EXTRACTION

Enhanced Oil Recovery—Chemical

DOE/BETC/OR-21. Chemicals for Enhanced Oil Recovery, Annual Report, Oct. 1, 1980–Sept. 30, 1981. Oak Ridge National Laboratory. May 1983. 80 pp. The main objective of this project was to reduce barriers to implementation of micellar flooding arising from the cost and/or supply of chemicals. The work included a search for suitable raw materials in waste streams or in low-cost by-products, evaluation of these components, research supporting field production of biopolymers, microbiological production of cosurfactants, and a search for competitive adsorbates or sacrificial agents. Emphasis was on substances from other than petroleum sources. Because of the large volume of organic chemicals having low value produced in the pulping of wood, considerable attention was given to the paper industry.

DOE/ET/13077-80. Commercial Scale Demonstration Enhanced Oil Recovery by Micellar-Polymer Flood, Annual Report, October 1981–September 1982. Marathon Oil Co. June 1983. 94 pp. This commercial-scale test is located in Crawford County, Ill. It encompasses 407 acres of Robinson sand reservoir and covers portions of several waterflood projects that were approaching economic limit. The project includes 248 acres developed on a 2.5-acre five-spot pattern and 159 acres developed on a 5.0-acre five-spot. After 18 percent of pore volume injection, the 2.5-acre pattern oil cut increased from 5 to a peak of 12 percent. Oil cut has been in excess of 5 percent since March 1978, but the pattern appears to be on a shallow decline. After 23 percent of pore volume injection, the 5.0-acre pattern oil cut gradually increased from 4 percent to 11.3 percent. As a result of project operations, 848,062 barrels of oil have been recovered from the project area.

Enhanced Oil Recovery—Thermal

DOE/SF/10761-3. Field Demonstration of the Conventional Steam Drive Process with Ancillary Materials, Final Report. CLD Group, Inc. June 1983. 142 pp. This project evaluated the potential of chemicals for increasing the sweep of steam drive and displacement of oil. The project was conducted in these phases: (1) laboratory work on chemical screening, foam system development, and bench testing of alternate emplacement techniques; (2) four small field tests using various embodiments of the process in different reservoir settings; and (3) a longer-term verification field test to assess the process under standard field operating conditions. This final report completes the analysis of the field tests.

Enhanced Oil Recovery—Carbon Dioxide

DOE/BC/10331-9. Displacement of Oil by Carbon Dioxide, Second Annual Report, October 1981–September 1982. New Mexico Institute of Mining and Technology. June 1983. 118 pp. This report presents results of research to investigate and quantify factors that affect the performance of carbon dioxide flood processes in reservoir rocks. An apparatus is described in which displacement of oil by CO_2 at high pressure from pore networks etched in glass can be observed visually. A series of secondary and tertiary, first-contact and multiple-contact miscible displacements tests were performed. Equipment was developed for on-line measurements of mixing in one- and two-phase displacements, and a new device was designed to separate oil and water continuously in a chamber of very low dead volume. Results of one- and two-phase displacements validate the experimental techniques.

DOE/MC/16551-6. Enhanced Oil Recovery by CO_2 Foam Flooding, First Annual Report. New Mexico State University. June 1983. 88 pp. Significant progress was made in developing a commercial method to reduce the mobility of carbon dioxide in enhanced oil recovery processes. Experiments on gas mobility control, conducted in linear sand-pack models, show only a general correlation with the static foam test, which utilizes a blender to generate foam from an aqueous surfactant solution. All surfactants that produce reasonable quantities of foam in the blender test also impart some degree of mobility control to gas. The best mobility control additives, however, are only modest foam volume producers. Three basic chemical structures appear to show the most promise: (1) ethoxylated adducts of C_8–C_{14} linear alcohols, (2) sulfate esters of ethoxylated C_9–C_{16} linear alcohols, and (3) low molecular weight co-polymers of ethylene oxide and propylene oxide. Each of these types is compatible with normal oilfield brines, unaffected by the presence of crude oil, and stable under conditions common in a petroleum reservoir.

Western Gas Sands

DOE/BC/10253-7. **Development of Multi-Faceted Well Simulator, Final Report.** University of Oklahoma. May 1983. 78 pp. A multi-faceted well simulator program described in this report can be used to investigate the performance of hydraulically fractured gas wells completed in noncontinuous lenticular formations indigenous to the Rocky Mountain area. The simulator model consists of mathematical equations to simulate reservoir, fracture, and well performance under a variety of specified operating conditions. The operational simulator considers two-dimensional flow in the reservoir and one-dimensional flow in a vertical fracture that completely penetrates the reservoir in a vertical direction. The reservoir rock is assumed to be isotropic in nature with gas-bearing sand lenses randomly dispersed throughout the reservoir. Using a Monte Carlo analysis, a sand lens factor was introduced into the reservoir equations to simulate the effects of lenticular formations. Results are presented for both continuous and noncontinuous lenticular reservoirs to demonstrate the applicability of the simulator.

PROCESSING AND THERMODYNAMICS

Processing

DOE/BC/10525-4. **Mechanisms of Syncrude/Synfuel Degradation, First Annual Report, Sept. 15, 1981–Sept. 30, 1982.** Naval Research Laboratory. June 1983. 100 pp. Stability tests were conducted at three temperatures—43, 65, and 80°C—using identical experimental procedures. Shale-II diesel fuel was used as the base stock in a program studying the effect of nitrogen compound structure on solids formation. Extensive experimental work with 2,5-dimethylpyrrole (DMP) resulted in the development of a matrix for solids formation at three temperatures, time periods between 4 and 180 days, and for a 10-fold concentration range of DMP. A regular pattern for insolubles was found within the matrix. The DMP sediment contained 12 percent nitrogen and 20 percent oxygen, irrespective of the stress conditions or initial DMP concentration. Pyridines, quinolines, tetrahydroquinolines, pyrazoles, pyrrolidines, piperidines, and pyrazines exhibited much better stability than most pyrroles. However, a hindered phenol antioxidant improved the stability results for many compounds.

DOE/BETC/SP-83/10. **BETC Research Brief—Mechanisms of Syncrude/Synfuel Degradation.** Edited by Bill Linville. June 1983. 2 pp. Summarizes preceding report and gives major conclusions.

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GENERAL RESEARCH

Quarterly Reports

DOE/BETC/QPR-83/1. Liquid Fossil Fuel Technology. Quarter ending March 31, 1983. Edited by Bill Linville. July 1983. 72 pp. Progress reports on research projects conducted by Bartlesville Energy Technology Center personnel and contractors are given, with emphasis on liquid fossil fuel projects. Reports are included from BETC's Divisions of Extraction Research, Processing and Thermodynamics Research, Utilization Research, and Project Integration and Technology Transfer. Free subscription available upon request.

EXTRACTION

Enhanced Oil Recovery—General

DOE/BC/10116-20. Flow in Porous Media, Phase Behavior and Ultralow Interfacial Tensions: Mechanisms of Enhanced Petroleum Recovery, Final Report. University of Minnesota. July 1983. 266 pp. This report summarizes the 1981 papers and theses and features nine articles describing the accomplishments of the program during that year. The article titles are: "Vesicular Dispersions and Surfactant Waterflooding;" "Microemulsion Structure, Conductivity, Rheology;" "Patterns of Three-Liquid-Phase Behavior: Illustrated by Alcohol-Hydrocarbon-Brine-Mixtures;" "Thermodynamic Modelling of Pseudoternary Phase Behavior;" "Thermodynamic Modelling of Phase and Tension Behavior of Carbon Dioxide and Hydrocarbon Systems;" "How Water Spreads on Quartz or Glass;" "Porous Media: Structure, Strength, and Transport;" "Percolation and Conduction Phenomena in Disordered Composite Media;" and "Cold Stage Scanning Electron Microscopy of Crude Oil and Brine in Rock."

DOE/BETC-83/2. Contracts for Field Projects and Supporting Research on Enhanced Oil Recovery and Improved Drilling Technology. Progress Review No. 34, Quarter ending March 31, 1983. Edited by Bill Linville. July 1983. 92 pp. Status reports are given of various enhanced oil and gas recovery projects sponsored by the Department of Energy. The field tests and supporting research on enhanced oil recovery include chemical flooding, carbon dioxide injection, thermal/heavy oil recovery, microbial recovery, and residual oil determination. Other research includes resource assessment, extraction research, improved drilling methods, environmental technology, and oil recovery by gravity mining. Free subscription available upon request.

Enhanced Oil Recovery—Chemical

DOE/ET/12267-1. Oil Solubilization Studies, Final Report. Lehigh University. July 1983. 44 pp. The first of two microemulsion studies discussed concerns the thermodynamic activity of oil solubilized into swollen micelles in the presence of oil-soluble cosurfactants. Microemulsions using acidic cosurfactants were discovered and analytical methods developed for the determination of cosurfactant concentration in oil in order to determine the partition of cosurfactants into the oily core of swollen micelles. In the second study, the flocculation of certain soap-stabilized oil-in-water emulsions in the presence of salt up to 0.5 M was found to involve the development of a middle phase that spread over oil droplets and displaced the aqueous phase between oil droplets.

Enhanced Oil Recovery—Thermal

DOE/ET/12058-6. Williams Holding Lease Steamflood Demonstration Project Cat Canyon Field, Final Report. Getty Oil Co. July 1983. 166 pp. The objective of this pilot program was to evaluate the efficiency and economics of the steam displacement process for future full-scale development of the Cat Canyon S1-B reservoir and in similar heavy crude oil reservoirs. Steamflood response occurred over a 10-month period beginning in October 1977 in four of the nine pilot producers. Poor oil production and high water to oil ratios characterized steamflood performance. The steamflood injection was temporarily suspended from February 1980 to December 1981. Improvement in oil production and a decrease in the water to oil ratio resulted. Displacement injection was resumed in January 1982 at lower injection rates. Although steamflood response occurred in three of the nine producers, total pilot production declined steadily after January 1982. Displacement injection was permanently halted on Dec. 15, 1982.

Enhanced Oil Recovery—Carbon Dioxide

DOE/MC/08383-45. Little Knife Field CO_2 Minitest Billings County, North Dakota, Final Report, Volume I: Technical Report, Volume II: Appendices. Gulf Oil Exploration and Production Co. July 1983. Vol. I: 278 pp. Vol. II: 416 pp. A carbon dioxide minitest was conducted in the Mission Canyon Formation at Little Knife Field. The field test confirmed the results of laboratory CO_2 miscible displacement tests. The pattern sweep efficiency for CO_2 approached 52 percent in the minitest area. A total of 3,100 ft^3 of CO_2 was required per incremental barrel of displaced oil. The minitest indicated that the process has technical potential for commercialization in a dolomitized carbonate reservoir that has not been extensively waterflooded and has high remaining oil saturation.

DOE/MC/10865-13. CO_2 Formation Damage Study, Final Report. New Mexico State University. July 1983. 238 pp. This project was aimed at defining the mechanisms responsible for formation damage during the use of carbon dioxide to enhance tertiary oil recovery. Four possible damage mechanisms were identified: (1) precipitation of reservoir minerals in the vicinity of the producing well as CO_2 escapes from the water phase due to pressure draw down, (2) plugging of reservoir interstices by insoluble organic solids precipitated as the CO_2 dissolves in crude oil, (3) formation of an immobile gas phase, predominately CO_2, that would drastically lower the effective permeability to oil and water, and (4) dissolution of cementation that could allow fines to migrate in the reservoir and plug tiny flow passages. Each of these mechanisms was investigated using laboratory experiments, and remedies are suggested for each.

Western Gas Sands

DOE/BC/10215-27. Numerical Model of Massive Hydraulic Fracture, Second Annual Report, September 1981–August 1982. Oral Roberts University. July 1983. 81 pp. This report describes the development of three numerical models for predicting hydraulic fracture growth: (1) a blanket formation model with leak-off neglected and fracture shape assumed, (2) a blanket formation model with leak-off included and derived fracture shape, and (3) a lenticular formation model. The development of the two models for blanket formations are preliminary steps in predicting hydraulic fracture growth in lenticular formations. Significant progress was made on these two models, and preliminary work was done on the lenticular model.

PROCESSING AND THERMODYNAMICS

Processing

DOE/NBM-1072. Metal Coordination Chemistry: Removal and Recovery of Metal Compounds From Heavy Crude and Shale Oils with Multidentate Ligands. Lawrence Berkeley Laboratory. July 1983. 126 pp. The molecular characterizations of inorganic arsenic and organoarsenic compounds found in oil shale and oil shale retort and process waters has given new insight into developing innovative methods to remove these metal compounds from oil shale retorting products. This study found that catechol derivatives may aid in the removal of inorganic and organoarsenic compounds from retort products. A synthesized polymer was modified with catechol, and its reactivity with the characterized arsenic compounds is being determined. A complementary study addressed the molecular characterizations and profile identifications of vanadyl porphyrin and non-porphyrin complexes in various heavy crudes and their asphaltenes. The results of these studies should benefit the industry in exploration studies and catalyst poisoning experiments.

Characterization

DOE/BETC/PPS-83/3. Motor Gasolines, Winter 1982–83. E. M. Shelton. July 1983. 72 pp. The analytical data for 1,330 samples of motor gasoline were submitted to BETC for study, calculation, and compilation under a cooperative agreement with the American Petroleum Institute. The samples were collected from service stations throughout the country and analyzed in the laboratories of various refiners, motor manufacturers, and chemical companies. The data are tabulated by groups according to grades for 17 marketing districts in the United States. A map shows marketing areas, districts, and sampling locations. Also included are charts indicating the trends of selected properties of motor fuels since 1959 and octane distribution percentage charts for the country.

UTILIZATION

Adaptive Engineering

DOE/BETC/RI-83/4. Vehicle Emission Characteristics Using Mechanically Emulsified Alcohol/Diesel Fuels. D. E. Seizinger, J. R. Allsup, F. W. Cox, A. L. Brooks, and R. O. McClellan. July 1983. 12 pp. Alcohol/diesel fuel mixtures have been used to fuel diesel engines typically operated at steady-state mode. These systems have been limited to introducing alcohol by fumigation or by premixed fuel. An optional method of alcohol utilization involves emulsifying the alcohol/diesel fuel mixture prior to introduction into the engine fueling system. A light-duty diesel vehicle fueled with an emulsified alcohol/diesel fuel was operated under cyclic mode. Emission and fuel economy measurements were taken during vehicle operation. The test results showed the volumetric fuel economy decreased slightly. The emissions data indicate no significant changes in the total release of biological activity into the environment.

Alternate Fuels

DOE/BC/10343-1. Effect of Low-Proof Alcohol on Crankcase Oil Dilution in an Otto-Cycle Engine, Final Report. Oregon State University. July 1983. 40 pp. The use of low-proof ethyl alcohol as an internal combustion engine fuel may create some operational problems if alcohol or water accumulate in the crankcase oil. A laboratory experiment was conducted using a 1974 Ford, 2.3 liter, 4-cylinder overhead cam engine. The study evaluated those parameters that might result in the dilution of crankcase oil with excessive amounts of alcohol or water. Test results indicate that the use of ethanol at proofs less than 130 may result in the accumulation of water in the crankcase of this engine, leading to inadequate engine lubrication.

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EXTRACTION

Enhanced Oil Recovery—General

CONF-821199. Proceedings of Forum on Subsidence Due to Fluid Withdrawals. U.S. Department of Energy and the Ministry of Energy and Mines of the Republic of Venezuela. August 1983. 146 pp. An international conference on subsidence was held Nov. 14-17, 1982, at Checotah, Okla. This report contains the presentations and discussions on the key issues of (1) the state of the art of compaction and subsidence, (2) the problems of subsidence and their definition, and (3) recommendations for research.

DOE/BC/10308-30. Assessment of Gamma-Inject Logging Techniques for the Determination of Residual Oil Saturation, Final Report. Argonne National Laboratory. August 1983. 80 pp. Work was completed to assess the feasibility of logging formations by injecting radioactive fluids into depleted reservoirs and measuring the gamma signal returning to the borehole. The theoretical work established the relationship between residual oil and detected gamma signal and estimated the error in the determined value of residual oil. The experimental work involved relating measured gamma signals from fluids and rock to various conditions expected during oil logging. The measured gamma signal was affected by (1) the residual oil levels in the rock cores, (2) the rock wetting fluid, (3) the surfactant concentration of the radioactive solution, and (4) the type of gamma-emitting radionuclide.

DOE/BC/10309-16. Development of an Improved Method for the Analysis of Pressure Core Samples, Final Report. GeoChem Research Inc. August 1983. 48 pp. The objective of this work was to develop a program to handle and analyze pressure core samples collected at the well site. As a requirement of the analytical design, all hydrocarbons and water were extracted from the core samples and measured directly. The volumes of the evolved gases were measured after frozen samples were thawed in a sealed chamber. The gas composition was then determined by standard gas chromatography; the water content was determined by a modified Dean-Stark procedure. A method is also described for measuring porosity and permeability at overburden stress.

DOE/BETC/IC-83/4. Abandoned Oil Fields in Oklahoma. James W. Chism. August 1983. 106 pp. A considerable amount of petroleum may be economically recoverable at today's oil prices from reservoirs abandoned when prevailing prices were lower. A major barrier to renewed production from these abandoned fields has been the lack of pertinent, readily available, systemized information for oil producers. The DOE developed this listing from the Petroleum Data System at the University of Oklahoma; the list includes 166 abandoned oil fields in Oklahoma that produced 10,000 or more barrels of oil prior to abandonment.

Enhanced Oil Recovery—Chemical

DOE/BC/00048&51-29. Selection of Reservoirs Amenable to Micellar Flooding, Final Report, October 1978-December 1982. Gary Energy Corp. and Intercomp Resource Development and Engineering, Inc. August 1983. 154 pp. A chemical flood predictive model (CFPM) for micellar-polymer processes was developed. It is applicable to waterflooded sandstone reservoirs and is based on an analysis of all available laboratory and field data. The CFPM also can be used to select the better micellar-polymer prospects in Mid-Continent and California regions and to aid in the design and development of micellar-polymer floods.

DOE/SF/01424-47. Big Muddy Low-Tension Flood Demonstration Project, Fifth Annual Report, April 1982-March 1983. Conoco, Inc. August 1983. 126 pp. This commercial-size demonstration project consists of nine 10-acre injection patterns in the Big Muddy Oil Field, 15 miles east of Casper, Wyo. The test was designed to provide data for commercialization of the chemical injection process for this and similar Wyoming and Colorado oil fields. This report reviews the project performance during the last part of slug injection, with particular emphasis on the analysis of early oil response and injectivity. Pilot testing for an oil-treating facility is also discussed.

Enhanced Oil Recovery—Carbon Dioxide

DOE/BC/10344-8. Investigations of Enhanced Oil Recovery Through Use of Carbon Dioxide, Second Annual Report, Oct. 1, 1981-Sept. 30, 1982. Louisiana State University. August 1983. 96 pp. The objective of this research is to provide data that will aid in the selection of reservoirs amenable to CO_2 flooding

and improve related field operating procedures. The report describes the phase behavior of 43 mixtures of synthetic oil and carbon dioxide. Four synthetic oils composed of selected paraffinic, aromatic, and naphthenic hydrocarbons were examined. The results show that the phase equilibria determined for mixtures of CO_2 with simple synthetic oils resemble closely those reported for complex natural crude oils. Oil recoveries were made from 22 slim-tube displacements of dead and one of live Brookhaven oil using CO_2 as an injection fluid. The lower minimum miscibility pressures observed for the live versus the dead oil displacements suggest that the C_2 through C_5 hydrocarbons have a major effect on the displacement mechanism.

Enhanced Oil Recovery—Thermal

DOE/ET/12059-6. **The "200" Sand Steamflood Demonstration Project, Sixth Annual Report, June 1981–June 1982.** Santa Fe Energy Co.—Western Division. August 1983. 22 pp. This project was initiated in the "200" Sand Pool to demonstrate the operational, recovery, and economic aspects of steamflooding a typical heavy oil reservoir that had responded poorly to cyclic stimulation. This pool contains about 50 million barrels of oil-in-place in a structure that is 400–700 ft deep. The first phase of the project, a pilot test with four 2.35-acre inverted seven-spot steam drive patterns, showed good response. The second phase expanded the pilot area to 14 fully developed 2.35-acre inverted seven-spot patterns, consisting of 42 producing wells and 14 injection wells.

Western Gas Sands

DOE/NV/10249-6. **Western Gas Sands Project Status Report, July–September 1982.** CER Corp. August 1983. 134 pp. This report summarizes the quarterly progress of government-sponsored projects to increase gas production from low permeability gas sands of the western United States. During the quarter, Terra Tek, Inc., conducted spray drying tests to determine the possibility of making hollow spherical proppants using a single-fluid nozzle in a counter-current air flow dryer. At Los Alamos National Laboratory, work has progressed on utilizing relaxation data to determine the distribution of pore surface-to-volume ratios in core samples. Work continued at Sandia National Laboratory on thermal neutron cross section measurements. The stress test display and control console hardware were completed for the DOE Well Test Facility, now being used for the Multi-Well Experiment (MWX). Drilling, coring, logging, casing, and cementing of MWX Well No. 2 was completed.

PROCESSING AND THERMODYNAMICS

Processing

DOE/BC/10435-1. **A Laboratory Study of the Long-Term Mixing Across the Quiescent Horizontal Interface Between Two Crude Oils of Different Densities, Final Report, Oct. 1, 1981–May 1, 1983.** T. S. Associates. August 1983. 128 pp. For this study on the mixing between crudes in field storage reservoirs, laboratory tests were performed in a plexiglass tank containing equal layers of an Alaskan North Slope and an Arabian Light crude oil. Oil samples were obtained over a period of 360 days from several levels and horizontal positions within the tank and were analyzed for sulfur and vanadium contents. The results show that a slow mixing occurs between the two oil layers with increasing time; the vertical distribution of properties within the tank change gradually from the initial step profiles to smooth, monotonically varying ones.

Characterization

DOE/BETC/PPS-83/4. **Heating Oils, 1983.** E. M. Shelton. August 1983. 40 pp. The properties of 195 heating oils were submitted to BETC for study and compilation under a cooperative agreement with the American Petroleum Institute. The fuels were manufactured by 25 petroleum refining companies in 83 domestic refineries. The data are tabulated according to grades for 16 marketing districts, shown on a map. Trend charts are included showing average properties of the six grades of fuel for the past several years. Summaries of the test results for 1983 are compared with 1982 data.

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