

*Emerging Technologies for the
Natural Gas Industry in the Spotlight*



U.S. Department of Energy's

**NATURAL GAS
CONFERENCE PROCEEDINGS**

Houston, Texas

March 24-27, 1997

Host and Sponsor:

Federal Energy Technology Center

U.S. Department of Energy

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Foreword

The U.S. Department of Energy (DOE) 1997 Natural Gas Conference was sponsored and hosted by the Federal Energy Technology Center (FETC) on March 24 to 27 in Houston, Texas. FETC is the lead center for DOE's Natural Gas Research and Development Program.

DOE sponsors technology research and development for the gas industry. Periodically, DOE presents the results of this research in a conference format to provide technology transfer to interested parties and to keep the public informed. The Natural Gas Conference theme, *Emerging Technologies for the Natural Gas Industry*, reflects the need for a consistent focus by the U.S. to support technology development for the natural gas industry.

Attendees numbered 300 from industry, academia, national laboratories, DOE, and other Government agencies. Two preconference off-site workshops (Russian Drilling Technology and Geophysical Applications) and a site visit to a DOE-owned Liquid Phase Reactor (Gas-to-Liquids) facility were held. The conference format included four seminars, a general session, six technical sessions, a poster session, and a banquet. In total, there were 5 keynote addresses, 39 papers, 28 poster presentations, and 15 exhibits. Topics covered in the technical sessions and seminars included gas reserves, low-permeability reservoirs, natural gas processing/gas-to-liquids, natural gas processing/gas upgrading, natural gas storage, drilling and completion technologies, environmental applications for the petroleum industry, 2-D/3-D seismic applications, and the natural gas atlas series.

The papers and presentations in this document were produced primarily from electronic files provided by the authors. They have been neither refereed nor extensively edited. The conference Proceedings was provided to participants on a CD-ROM. The papers and presentations are available on the FETC home page at <http://www.fetc.doe.gov> (see Calendar of Events).

Conference Technical Team

Charles W. Byrer

Rodney D. Malone

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Keynote Addresses and Biographies

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Introduction and Welcome to the 1997 Natural Gas Conference; Rita A. Bajura — Director, U.S. Department of Energy, Federal Energy Technology Center

Biography (Bajura)

The Forward March of Natural Gas; Kenneth L. Lay — Chairman and Chief Executive Officer, Enron Corp.

Biography (Lay)

Natural Gas: An Optimistic Outlook; Charles R. Matthews — Commissioner, State of Texas Railroad Commission

Biography (Matthews)

DOE's Perspective on Natural Gas; C. Kyle Simpson — Senior Policy Advisor to the Secretary, U.S. Department of Energy

Biography (Simpson)

Advanced Technology Imperative For The E&P Industry; Myron Gottlieb — Vice President and General Manager, Supply Business Unit, Gas Research Institute

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There Ain't No Free Lunches; T. Scott Hickman — President, Society of Petroleum Engineers

Biography (Hickman)

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- (2.2) *A New-Generation Mud-Hammer Drilling Tool*, Annual Report; D. Pixton and D. Hall — Novatek, Inc.
- (2.3) *Disc Cutter Technology Applied to Drill Bits*; J.E. Friant — Excavation Engineering Associates, Inc.
- (2.4) *High Data Rate MWD Mud Pulse Telemetry*; W.R. Gardner — Halliburton
- (2.5) *Application and Needs for Advanced Multilateral Technologies and Strategies*; P.C. Crouse — Philip C. Crouse and Associates, Inc.

Session 2: Environmental Applications for the Petroleum Industry

- (2.6) *The Department of Energy's Environmental Research and Analysis Program: Strategies and Specifics*; R.P. Lindsey — National Petroleum Technology Office, U.S. Department of Energy; and M. Grabhorn — National Institute for Petroleum and Energy Research
- (2.7) *The Development of a Laser-Illuminated Infrared Imager for Natural Gas Leak Detection*; T.J. Kulp, P.E. Powers, and R. Kennedy — Sandia National Laboratories
- (2.8) *Results of Bench-scale Testing of a Mobile On-site NORM Treatment System in Texas and New Mexico*; D.W. Capone II, S. Chatterjee, T. Cleland, D. Fortunato, G. Roehrig, H.B. Walker, and T.O. Bush — BPF, Inc.
- (2.9) *Disposal of Nonhazardous Oil Field Wastes into Salt Caverns*; J.A. Veil, D. Elcock, M. Raivel, D. Caudle, R.C. Ayers, Jr., and B. Grunewald — Argonne National Laboratory

Session 2: 2-D/3-D Seismic Applications, Compartmentalized Sandstones and Carbonates

- (2.10) *Results of 3-D Seismic Carbonate Project, West Texas: Part 1 — Overview, Reservoir Characteristics, and Geophysics, and Part 2 — Borehole Electrical Images from Microresistivity Logs of the Fractured, Karsted, and Brecciated Ellenburger Group*; B.A. Cain — Shell Western E&P Inc.; and U. Hammes — Bureau of Economic Geology, The University of Texas at Austin

Session 2 — Natural Gas Geotechnical R&D Seminars (continued)

Session 2: 2-D/3-D Seismic Applications, Compartmentalized Sandstones and Carbonates (continued)

- (2.11) *Results of High Resolution Seismic Imaging Experiments for Defining Permeable Pathways in Fractured Gas Reservoirs*; E.L. Majer, J.E. Peterson, T. Daley, K. NiHei, L. Myer, D. Vasco, and C. Doughty — Center for Computational Seismology, Lawrence Berkeley National Laboratory; J. Queen, P. D'Onfro, and W. Riser — Conoco Inc.; and A. Datta-Gupta — Texas A&M University

Session 2: Natural Gas Atlas Series, Gulf Coast, Offshore and Appalachian Basins

- (2.12) *Adding Value to the Atlas of Major Appalachian Gas Plays*; D.G. Patchen, R. McDowell, and K.L. Avary — West Virginia Geological Survey
- (2.13) *Chronostratigraphic Hydrocarbon Plays and Depositional Styles in the Northern Gulf of Mexico*; S.J. Seni and W.L. Fisher — The University of Texas at Austin; and J.P. Brooke, D.A. Marin, and E.G. Kazanis — Minerals Management Service, U.S. Department of the Interior

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- (4.1) *3-D Seismic Evidence of the Effects of Carbonate Karst Collapse on Overlying Clastic Stratigraphy and Reservoir Compartmentalization*; B.A. Hardage, D.L. Carr, D.E. Lancaster, J.L. Simmons, Jr., R.Y. Elphick, V.M. Pendleton, and R.A. Johns — Bureau of Economic Geology, The University of Texas at Austin
- (4.2) *Reserves in Western Basins*; R.H. Caldwell — The Scotia Group, Inc.
- (4.3) *Recent Developments in the Gas System Analysis Model (GSAM)*; R.E. Baron — ICF Kaiser, Inc.
- (4.4) *Lower-48 Oil and Gas Resource Characterization With the GASIS Database*; R.H. Hugman, P.S. Springer, and E.H. Vidas — Energy and Environmental Analysis, Inc.

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- (P2)** *Multistrata Exploration and Production Study*; R.G. Brunk and L.K. Hawkins — The College of West Virginia

- (P3)** *Assessing and Forecasting Natural Gas Reserve Appreciation in the Gulf Coast Basin*; E.M. Kim and W.L. Fisher— Bureau of Economic Geology, The University of Texas at Austin

- (P4)** *Landfill Gas Conversion to a Contaminant-Free Methane-Carbon Dioxide Reformer Feedstock for Methanol Synthesis*; W.J. Cook, L.A. Siwajek, and W.R. Brown — Acion Technologies, Inc.

- (P5)** *Integrated Process for Coalbed Brine and Methane Disposal*; J.H. Tait — Aquatech Services, Inc.

- (P6)** *A Focus on Offshore Safety: Recent Reports by the Marine Board of the National Research Council*; D.W. Perkins — Marine Board, National Research Council

- (P7)** *Greater Green River Basin Production Improvement Project*; B.B. DeJarnett — BBD Consulting; F.H. Lim — Union Pacific Resources Group; and D. Calogero — Engineering Consultant

- (P8)** *Low Quality Natural Gas Sulfur Removal and Recovery CNG Claus Sulfur Recovery Process, Pilot Plant Test Program*; B.W. Klint, P.R. Dale, and C. Stephenson — Bovar Corp. for CNG Research Company

- (P10)** *Nitrogen Removal From Low Quality Natural Gas*; D.B. Alvarado, M.F. Asaro, J.L. Bomben, A.S. Damle, and A.S. Bhowan — SRI International

- (P11)** *Low-Quality Natural Gas Sulfur Removal/Recovery System*; K.A. Lokhandwala, M. Ringer, H. Wijmans, and R.W. Baker — Membrane Technology and Research, Inc.

- (P12)** *Fracturing Fluid Characterization: State-of-the-Art Facility and Advanced Technology*; S. Shah and M. Asadi — The University of Oklahoma

- (P13)** *North Slope of Alaska Gas Hydrate Test Well Program*; T.S. Collett — U.S. Geological Survey

- (P14)** *Non-Oxidative Conversion of Methane with Continuous Hydrogen Removal*; R.W. Borry III and E. Iglesia — University of California at Berkeley, E.O. Lawrence Berkeley National Laboratory

Session 5 — Poster Session (continued)

- (P15) *Conversion of Associated Natural Gas to Liquid Hydrocarbons*; A.H. Singleton and P.G. Cooper — Energy International Corporation
- (P16) *Long Life Catalytic Membrane Reactors for Spontaneous Conversion of Natural Gas to Synthesis Gas*; M. Schwartz, J. White, S. Deych, J. Millard, M. Myers, and A. Sammells — Eltron Research, Inc.
- (P17) *Tight Gas Reservoir Simulation: Modeling Discrete Irregular Strata-Bound Fracture Networks and Network Flow, Including Dynamic Recharge from the Matrix*; M.L. McKoy and W.N. Sams — EG&G Technical Services of West Virginia, Inc.
- (P18) *Ultrasonic and Numerical Modeling of Reflections from Simulated Fractured Reservoirs*; S. Theophanis — Science Research Laboratory; and X. Zhu — Earth Resources Laboratory, The Massachusetts Institute of Technology
- (P19) *A Geological and Geophysical Assessment of the Royal Center Gas Storage Field in North-Central Indiana, A Joint NIPSCO, DOE & GRI Case Study*; T.H. Mroz — Federal Energy Technology Center; J. Crismon — NIPSCO; T. Fasnacht — Gas Research Institute; S. Schaffer — Polaris Energy; and E. Majer — Lawrence Berkeley Laboratory
- (P20) *Fractal Interrelationships in Field and Seismic Data*; T.H. Wilson, J. Dominic, and J. Halverson — West Virginia University
- (P22) *Improved Storage Efficiency Through Geologic Modeling and Reservoir Simulation*; J.R. Ammer, T.H. Mroz, and G.L. Covatch — Federal Energy Technology Center, U.S. Department of Energy
- (P23) *GTI Online — Matching Gas Technologies With Global Gas Markets*; M. Lang and D. Manor — IEA International Centre for Gas Technology Information
- (P24) *Comprehensive Geostatistical Technology on PC Platform*; C. Stevenson — Correlations Company
- (P25) *Natural Gas Research Energy Resources Program of the U.S. Geological Survey*; T.S. Dyman, T.S. Collett, R.D. Hattinger, R.C. Johnson, V.F. Nuccio, J.L. Ridgley, R.T. Ryder, J.W. Schmoker, and C.J. Wandrey — U.S. Geological Survey
- (P26) *The Interplay of Fractures and Sedimentary Architecture: Natural Gas from Reservoirs in the Molina Sandstones, Piceance Basin, Colorado*; J.C. Lorenz — Sandia National Laboratories

Session 5 — Poster Session (continued)

- (P27)** *Geobotanical and Lineament Analysis of Landsat Satellite Imagery for Hydrocarbon Microseeps*; T.A. Warner — West Virginia University
- (P28)** *BIODESULFTM, A Novel Biological Technology for the Removal of H₂S From Sour Natural Gas*; K.C. Srivastava, J.J. Stashick, P.E. Johnston, and N.K. Kaushik — ARCHTECH, Inc.

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Session 6 — Low Permeability Reservoirs: Improving Integration and Application of Technology

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- (6.1) *Geologic Characterization and Assessment of In-Place Resources, Upper Cretaceous and Lower Tertiary Low Permeability Gas-Bearing Strata, Wind River Basin, Wyoming*; R.C. Johnson, T.M. Finn, R.A. Crovelli, V.F. Nuccio, W.R. Keefer, and R.H. Balay — U.S. Geological Survey
- (6.2) *Fracture Detection, Mapping, and Analysis of Naturally Fractured Gas Reservoirs Using Seismic Technology*; H.B. Lynn, K.M. Simon, and W. Beckham — Lynn Incorporated
- (6.3) *Optimizing Technologies for Detecting Natural Fractures in the Tight Sands of the Rulison Field, Piceance Basin*; V.A. Kuuskraa — Advanced Resources International, Inc.; D. Decker — Basin Energy; and H. Lynn — Lynn Incorporated
- (6.4) *Naturally Fractured Gas Reservoirs Detection Optimization: Wind River Basin*; D.R. Phillips and R.E. Grimm — Blackhawk Geometrics, Inc.; and H.B. Lynn and K.M. Simon — Lynn Incorporated

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Session 7 — Natural Gas Processing/Gas to Liquids: Development of Downstream Technologies

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- (7.1) *Thermoacoustic Natural Gas Liquifier*; G. Swift — Los Alamos National Laboratory
- (7.2) *Economics of Alaska North Slope Gas Utilization Options*; E.P. Robertson — Idaho National Engineering and Environmental Laboratory; and C.P. Thomas — Petroleum Recovery Research Center, New Mexico Tech
- (7.3) *Methyl Chloride via Oxyhydrochlorination of Methane*; R.F. Jarvis, Jr. — Dow Corning Corporation
- (7.4) *Methane Conversion to Olefins, Higher Hydrocarbons and Oxygenates in Low Temperature Non-Equilibrium Plasmas*; R.G. Mallinson and L.L. Lobban — Institute for Gas Utilization Technologies, University of Oklahoma

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Session 8 — Natural Gas Processing/Gas Upgrading

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- (8.1) *Field Test Results of the Physical Solvent N-Formyl Morpholine for Gas Treating Applications*; N. Palla and A.L. Lee — Institute of Gas Technology
- (8.2) *Nitrogen Removal From Natural Gas Using Membranes*; K.A. Lokhandwala, M. Ringer, H. Wijmans, and R.W. Baker — Membrane Technology and Research, Inc.
- (8.3) *Sol-Gel Processing of Inorganic Membranes for Natural Gas Purification*; C.J. Brinker and J. Collins — Sandia National Laboratories; and C-Y. Tsai and U. Lu — Advanced Materials Laboratory, University of New Mexico
- (8.4) *Microbial Sweetening of Low Quality Sour Natural Gas*; C. Rai — Texas A&M University-Kingsville

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Session 9 — Natural Gas Storage: Advancing Technology to Improve Storage and Efficiency

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- (9.1) *Fracture Stimulation Field Demonstration Projects*; S.R. Reeves, L.J. Pekot, and G.J. Koperna — Advanced Resources International, Inc.
- (9.2) *Investigation of Storage Well Damage Mechanisms*; V.J. Yeager — Halliburton Energy Services
- (9.3) *Performance Tests of 12-Inch Multipath Ultrasonic Flow Meters*; T. Grimley — Southwest Research Institute
- (9.4) *Natural Gas Storage Utilization: Current Market Drivers and Probable Trends*; K.L. Beckman, P.L. Determeyer, E.H. Mowrey, and P.F. O'Connor — International Gas Consulting, Inc.

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- (10.1) *Steerable Percussion Air Drilling System*; H. Bui, J. Meyers, and S. Swadi — Smith International, Inc.
- (10.2) *Integrated Underbalanced Directional Drilling System, Interim Report, for Period of Performance 10/1/95-2/14/96*; D.D. Gleitman — Sperry-Sun Drilling Services
- (10.3) *High-Pressure Downhole Pump Jet-Assist Drilling*; S. Veenhuizen — FlowDril Corporation; and J. Duda — Federal Energy Technology Center
- (10.4) *Development and Testing of Advanced Drilling Products*; G.H. Medley, J.H. Cohen, W.C. Maurer, W.J. McDonald, and G.T. Pittard — Maurer Engineering Inc.
- (10.5) *Liquid-Free Stimulations — CO₂/Sand Dry-Frac*; R.L. Mazza — Petroleum Consulting Services
- (10.6) *Review of Hydraulic Fracture Mapping Using Advanced Accelerometer-Based Receiver Systems*; N.R. Warpinski, J.E. Uhl, and B.P. Engler — Sandia National Laboratories

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