Society of Petroleum Engineers
Continuing Education Short Course

Practical Aspects of CO_2 Flooding EOR, and CO_2 Geosequestration

Instructors: Mr. Charles E. Fox, P.E., Kinder Morgan CO_2 Company, L.P.
Dr. S. M. (Sam) Avasthi, P.E., Avasthi & Associates, Inc.
Dr. Michael H. (Mike) Stein, Premium Petroleum Consulting
Dr. J. M. (Jay) Avasthi, Avasthi & Associates, Inc.

Duration: One Day

Who Should Attend

Petroleum engineers, reservoir engineers, production engineers, facilities engineers, managers, government officials, and others involved or interested in CO_2 flooding or in hydrocarbon gas flooding, for improving oil recovery from oilfields around the world, and in CO_2 geosequestration.

Since this topic is of tremendous interest to the SPE members around the world, presentation of this course is expected to attract large attendance; therefore, those who are interested in attending this course should register early. **Since Excel programs will be provided in the class, the course registrants should plan to bring their notebook computers to the class.**

About the Course

This course is based on the SPE Monograph Volume 22, **"Practical Aspects of CO_2 Flooding"**, published in 2002, and is an outgrowth of The University of Texas of the Permian Basin/ SPE CO_2 Conferences and short-courses held in Midland, Texas, in December, for the past 12 years. The co-authors of the monograph presented a review of the monograph at the December 2002 Conference. The authors' presentations and the monograph were very well received by the Conference attendees, and it is the instructors' opinion that this course and the monograph should also be very well received by the SPE members outside the Permian Basin area as well. The instructors intend to present this course before the SPE meetings around the world, wherever there is an interest in improving oil recovery from oilfields, by CO_2-flooding or by hydrocarbon gas flooding, and in CO_2 geosequestration, a topic of growing interest to the SPE members around the world. In teaching this course, the instructors plan to: (1) spend most of the time discussing the practical aspects of CO_2 flooding, and keep discussion of the theoretical topics to bare minimum, (2) discuss economics of CO_2 flooding (vis-à-vis water flooding), (3) give the course attendees some practical and useful problems to work on, (4) discuss CO_2 geosequestration wherever there is interest in this topic, and (5) provide each course attendee a workbook containing copies of the instructors' PowerPoint presentations, and solutions to the problems.

The co-instructors, all seasoned engineers and longstanding members of the SPE, offer their extensive experience and expertise in practical aspects of CO_2 flooding to teaching this course to the SPE members around the world. In addition, the co-instructors plan to invite all co-authors of the monograph, and other CO_2 flooding experts, who may be attending the SPE meeting before which the course is to be presented, to answer questions from the course attendees.

Instructors' Biographies

Mr. Charles E. (Chuck) Fox, P.E., is Vice President of Operations and Technology at Kinder Morgan CO_2 Company L.P., in Houston, Texas. In addition to managing operations of the McElmo Dome CO_2 source field and 1,000 miles of CO_2 pipelines, he is responsible for his company's oil and gas CO_2 EOR operations, which include the 5 billion barrel original-oil-in-place (OOIP) Yates field, the 3 billion barrel OOIP SACROC field, and the Snyder Gasoline Plant.

Mr. Fox is a co-instructor of the popular SPE courses on the topics of '**Practical Aspects of CO_2 Flooding EOR**', and '**Geological Sequestration of CO_2**'. He is one of the co-authors of the SPE Monograph Volume 22, '**Practical Aspects of CO_2 Flooding**', published in 2002, on which the '**Practical Aspects of CO_2 Flooding EOR**' course is based. He was an instructor for several short-courses held at the annual CO_2 conferences in Midland, Texas, which were sponsored by the University of Texas of the Permian Basin and the SPE.

Mr. Fox was Chairman of the Program Committee of the SPE/DOE Fourteenth Symposium on Improved Oil Recovery, held in Tulsa, Oklahoma, during April 2004. He holds a MS degree in Petroleum Engineering from Stanford University, and a BS degree in Mechanical Engineering from Rice University. He is a registered professional engineer in Texas and New Mexico, and a longstanding member of the SPE.

Dr. S. M. (Sam) Avasthi, P.E. is President of Avasthi & Associates, Inc., a worldwide petroleum consulting company, headquartered in Houston, Texas. In addition to managing the company, that he founded in 1990 and that now provides Petroleum Engineering, Geomechanics and Geosciences, CO_2 Flooding EOR and CO_2 Geosequestration, Oil & Gas Field Operations, and Management Consulting Services around the world, he is active in providing consulting and training services in his areas of expertise.

Dr. Sam Avasthi has more than 38 years of worldwide oil & gas industry experience in oil & gas reservoir engineering and simulation, mature oilfield revitalization, CO_2 Flooding EOR project design, evaluation and optimization, gas, gas-condensate, volatile oil, and black oil reservoir asset optimization, and training. He has lectured on numerous topics in his areas of expertise in the United States, Japan, South-East Asia, the Middle East, Europe, and Latin America.

Dr. Sam Avasthi is a co-instructor of the popular SPE courses on the topics of '**Practical Aspects of CO_2 Flooding EOR**', and '**Geological Sequestration of CO_2**', and a new SPE course on the topic of **'Optimizing Gas Fields'.** In his other SPE activities, during the last few years, a paper co-authored by him on **'Planning EOR Projects'**, was presented at the SPE International Petroleum Conference in Mexico, held in Puebla, Mexico, during November 2004; and an article based on that paper was published under Management Series in March 2005 issue of JPT. Another paper co-authored by him on **'Planning EOR Projects in Offshore Oil Fields'** was presented at the Latin American

and Caribbean Petroleum Engineering Conference (LACPEC) in Rio de Janeiro, Brazil, during June 2005.

Dr. Sam Avasthi is an engineering alumnus of Indian School of Mines, Imperial College, and Texas A&M University. He earned a Ph.D. degree in Petroleum Engineering from Texas A&M University, and thereafter was a Research Fellow in Chemical Engineering at Rice University. He is a registered professional engineer in Texas, a senior member of the SPE, and a Technical Editor for the *SPE Reservoir Evaluation & Engineering Journal*.

Dr. Michael H. (Mike) Stein retired from BP in 2006 after 28 years of service, and is currently an independent engineering consultant, specializing in enhanced oil recovery and integrated asset modeling.

With BP he was most recently a team leader of the Integrated Asset Modeling group in BP's Technology Center in Houston. He was involved in numerous technical service assignments with integrated asset modeling around the world, as well as teaching company courses on integrated asset modeling. He also directed research on applying integrated asset modeling to monitor corrosion and erosion on a real time basis, and to also couple integrated asset modeling with reservoir simulation. He has co-authored several SPE papers in the area of optimizing gas reservoirs through integrated asset modeling, and linking integrated asset modeling to real-time automation data to monitor corrosion and erosion.

Prior to working in the area of integrated asset modeling, Dr. Stein spent most of his 28 years with BP as a reservoir engineer. His efforts were primarily in the areas of CO_2 flooding and reservoir modeling. He has written many SPE papers in these areas, and he is one of the co-authors of the SPE Monograph Volume 22, '**Practical Aspects of CO_2 Flooding**'. In addition to this '**Practical Aspects of CO_2 Flooding EOR**' course, he is a co-instructor of one other SPE course: '**Optimizing Gas Fields**'. He also holds three U.S. Patents, two in enhanced coal bed methane (ECBM) production, and one in automatic waterflood history matching. In 1991 he received the Distinguished Inventor award (presented by the Intellectual Property Owners, Inc.) for a patent on nitrogen injection in coal beds for enhanced coal bed methane (ECBM) recovery.

Dr. Stein is an engineering alumnus of the University of Missouri and Purdue University; he holds a B.S. degree in Chemical Engineering from the University of Missouri, and M.S. and Ph.D. degrees in Chemical Engineering from Purdue University. He is a long standing member of the SPE, has served on the SPE editorial committees, and chaired the SPE Reservoir Engineering committee to select papers for the Annual SPE Meeting.

Dr. J. M. (Jay) Avasthi is Executive Vice President and Director Geoservices (Geomechanics, Geosciences and CO_2 Geosequestration) at Avasthi & Associates, Inc., a worldwide petroleum consulting company headquartered in Houston, Texas, and provides consulting and training services in his areas of expertise.

Dr. Jay Avasthi has more than 29 years of worldwide oil & gas industry experience, including 24 years with Chevron Corporation, in geomechanics, well stimulation, rock

properties, wellbore stability, and sand production prediction research and supervision. His expertise includes acquisition, calibration and use of the in situ stress data for oil & gas well construction and production, and for waterflood and CO_2 flood enhanced oil recovery (EOR) project improvement; and solving fracturing stimulation, waste disposal through injection, wellbore stability, wellbore mechanics, and sand production prediction problems. He has taught several short courses, and conducted hands on training workshops, in his areas of expertise, around the world. He has authored/ co-authored numerous technical publications and a patent.

Dr. Jay Avasthi is an alumnus of Indian School of Mines (where he earned degrees in Applied Geology and Mining Engineering), the University of Minnesota (where he earned a M.S. degree in Geo-Engineering, with specialization in Rock Mechanics), and the University of Wisconsin-Madison (where he earned a Ph.D. degree in Mining Engineering, with specialization in Rock Mechanics). Thereafter, he worked in senior-level research and supervisory positions at Chevron for 24 years. He is a long-standing member of the SPE, a Technical Editor for the *SPE Reservoir Evaluation & Engineering Journal*, and has served as the SPE Los Angeles Basin Section Director and Program Chairman.

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One-Day Short Course

Registration for Short Course ..... *7:00 AM -8:00 AM*

Morning Session ..... **8:00 AM - 12:00 Noon**

1. Student Introduction/ Course Expectations and Introduction ..... 8:00 - 8:15
2. Review of CO_2 Process Mechanisms ..... 8:15 - 9:15
3. CO_2 Flooding Screening and Economics ..... 9:15 - 9:45
4. Scoping and Prophet Models ..... 9:45 - 10:00

Coffee Break ..... **10:00 - 10:15**

5. Reservoir Engineering Aspects of Design ..... 10:15 - 11:00
6. Class Problem - 1 (CO_2 Flood Scoping) ..... 11:00 - 11:30

6a. Discussion of Problem - 1 ..... 11:30 - 11:45

7. Corrosion ..... 11:45 - 12:00

Lunch ..... **12:00 - 1:00**

Afternoon Session ..... **1:00 PM - 5:00 PM**

8. Well Design ..... 1:00 - 1:15
9. Surface Facilities Design ..... 1:15 - 1:45
10. Class Problem - 2 (Compressor Design) ..... 1:45 - 2:00

10a. Discussion of Problem - 2 ..... 2:00 - 2:15

11. Implementation ..... 2:15 - 2:30

Coffee Break ..... **2:30 - 2:45**

11. Implementation (Continued) ..... 2:45 - 3:00
12. Operations/EHS Planning/EHS Video ..... 3:00 - 3:30
13. CO_2 Geosequestration ..... 3:30 - 4:30

Question and Answer Session ..... *4:30 - 4:45*

Feedback and Course Evaluation ..... *4:45 - 5:00*

Adjourn ..... **5:00 PM**

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Course Manual

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