

SPE EOR Conference at Oil and Gas West Asia 2014

Driving Integrated and Innovative EOR

**Muscat, Oman
31 March - 2 April 2014**

ISBN: 978-1-63266-318-4

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2014) by the Society of Petroleum Engineers
All rights reserved.

Printed by Curran Associates, Inc. (2014)

For permission requests, please contact the Society of Petroleum Engineers
at the address below.

Society of Petroleum Engineers
P. O. Box 833836
Richardson, Texas 75083-3836

Phone: (800) 456-6863
Fax: (972) 952-9435

books@spe.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2634
Email: curran@proceedings.com
Web: www.proceedings.com



Table of Contents

SPE-169652-MS

Experiences of Polymer Flooding Projects at Shengli Oilfield 1

C.H. Gao, Sinopec

SPE-169653-MS

Accurate Tool for IOR/EOR Screening and Estimating Target Recovery Factors 14

E.B. Zijlstra, J.N. Van Wunnik, J. Van Doren, A. Al Bimani, O. Wilson, S. Al Shidhani, Petroleum Development Oman

SPE-169657-MS

A Comparison of Asphaltene Deposition in Miscible and Immiscible Carbon Dioxide Flooding in Porous Media 25

S. Soroush, Delft University of Technology; P. Pourafshary, Sultan Qaboos University; M. Vafaie-Sefti, Tarbiat Modares University

SPE-169658-MS

Laboratory Investigation of Miscible CO₂ WAG Injection Efficiency in Carbonate 35

S. Duchenne, G. Puyou, P.R. Cordelier, G. Hamon, M.J. Bourgeois, Total S.A.

SPE-169662-MS

A Laboratory Study of Ionic Effect of Smart Water for Enhancing Oil Recovery in Carbonate Reservoirs 46

A.N. Awolayo, H.K. Sarma, A.M. Al-sumaiti, The Petroleum Institute

SPE-169663-MS

Predicting Interfacial Tension of Multiphase Systems Based on Computational Single-Molecule Quantum Mechanics and Thermodynamics Applying Four Different Physical Models and COSMO-Theory 70

M.V. Bennetzen, Maersk Oil Research & Technology Centre; M. Andersson, Nano-Science Center, Department of Chemistry, University of Copenhagen; K. Mogensen, Maersk Oil Research & Technology Centre

SPE-169664-MS

Conformance Control Treatments for Water and Chemical Flooding: Material Screening and Design 83

G. Glasbergen, Shell Global Solutions International; I.M. Abu-shiekah, Shell Oman; S. Balushi, J.N. Van Wunnik, Petroleum Development Oman



Table of Contents (*continued*)

SPE-169665-MS

Conformance Control Treatments for Water and Chemical Flooding: Opportunity and Risk Evaluation 93

*I.M. Abu-shiekh, Shell Oman; G. Glasbergen, Shell Global Solutions International; S. Balushi,
J.N. Van Wunnik, Petroleum Development Oman*

SPE-169668-MS

A New Modeling Approach to MEOR calibrated by Bacterial Growth and Metabolite Curves 104

H. Bueltemeier, TU Bergakademie Freiberg; H. Alkan, Wintershall GmbH; M. Amro, TU Bergakademie Freiberg

SPE-169669-MS

Potential of Alkaline Surfactant Polymer (ASP) Flooding in a Medium-Light Oil Reservoir with Strong Bottom Aquifer 119

*H.S. Al-sulaimani, Petroleum Development Oman; M. Stoll, Shell E&P International Ltd; J.N. Van Wunnik,
Petroleum Development Oman; R. Faber, F. Arkesteijn, Shell Intl. E&P BV*

SPE-169670-MS

Shifting to a New EOR Area for Sandstone Reservoirs With High Recovery, No Damage, and Low Cost 131

*M.M. Gadallah, M.A. Mahmoud, King Fahd University of Petroleum & Minerals ; H.S. Al-hashim, A.S. Sultan,
King Fahd University of Petr. & Min.*

SPE-169673-MS

Chemical EOR in Low Permeability Reservoirs 144

E. Delamaide, IFP Technologies Canada Inc.; R. Tabary, D. Rousseau, IFP Energies Nouvelles

SPE-169674-MS

A Novel Method to Model Low Salinity Water Injection in Carbonate Oil Reservoirs 159

*E.W. Al-shalabi, The University of Texas at Austin; K. Sepehrnoori, M. Delshad, University of Texas At Austin;
G. Pope, The University of Texas at Austin*

SPE-169675-MS

Longitudinal Heterogeneity Effects in Alkaline Surfactant Polymer Flooding Enhanced Oil Recovery 182

*H. Al Shahri, Petroleum Development Oman; M.B. Clennell, K. Liu, CSIRO Earth Sciences & Resource Engineering;
J. Liu, University of Western Australia; A. Mckinley, The University of Western Australia*

SPE-169676-MS

Microbial Enhanced Oil Recovery at High Salinities using Biosurfactant at Lower Concentrations 207

*M. Sassi, Sultan Qaboos Univeristy; Y.M. Al-wahaibi, S. Al-Bahry, A. Elshafie, A.S. Al-Bemani, S. Joshi,
A. Al-Hashmi, Sultan Qaboos University; M.S. Mandhari, Petroleum Development Oman*



Table of Contents (*continued*)

SPE-169678-MS

Maximising Steam Project Value in South Oman through Flexible Development Phasing and Integrated Reservoir Surveillance 214

S.M. Al-hinai, J. Tromp, M.O. Al Manahali, A. Belghache, M. Koning, A.O. Al Rabaani, R.S. Al-Adawi, S.J. Brissenden, T. Duggan, A. Alwazeer, Z. Qi Chen, Petroleum Development Oman

SPE-169680-MS

Implementation of Enhanced oil Recovery Techniques in India: New Challenges and Technologies 227

V.K. Baskaran, K.C. Dani, K.P. Kumar, A.M. Urkude, University of Petr & Energy Studies - India

SPE-169681-MS

A Systematic Study of the Polymer Visco-Elastic Effect on Residual Oil Saturation by Core Flooding 243

E.C. Vermolen, M.J. van Haasterecht, Shell Global Solutions International B.V.; S.K. Masalmeh, Shell Technology Oman LLC

SPE-169683-MS

Horizontal Well Steam Stimulation: A Pilot Test in Southern Oman 257

M. Mirza, Medco LLC; P. Aditama, M.M. Al-Raqmi, Medco Oman LLC; Z. Anwar, Medco LLC

SPE-169684-MS

Improving UR of Tight Sour Oil Field by Miscible Gas Injection (MGI) 270

M. Cobanoglu, Petroleum Development Oman; O.Q. Sarmiento, A. Jabri, S. Linthorst, Brunei Shell Petroleum Sdn Bhd; F. Mahruqi, PDO

SPE-169685-MS

Polymer Field Trial: Deployment of Intelligent Technologies for Horizontal Wells and Real-Time Approach for Surveillance 283

K.F. Awan, R. Mjeni, K. Abri, N. Bulushi, S. Rajhi, N. Azri, Petroleum Development Oman; A.B. Oguntimehin, Shell; J.E. Edwards, Schlumberger; J.G. Mohiddin, S. FURAISI, M.K. Sinha, Petroleum Development Oman

SPE-169686-MS

Reducing Key Uncertainties Prior to a Polymer Injection Trial in a Heavy Oil Reservoir in Oman 294

K. Abri, K.F. Awan, N. Bulushi, R. Mjeni, N. Azri, O. Riyami, S. Rajhi, S. Teeuwisse, Petroleum Development Oman; I. Shiekah, Shell; S.G. Douma, Shell International E&P Co.

SPE-169688-MS

Making Field-Scale Chemical EOR Simulations a Practical Reality using Dynamic Gridding 309

H. Hoteit, A. Chawathe, Chevron Corporation



Table of Contents (*continued*)

SPE-169689-MS

TPM's: A New Class of Viscoelastic Solutions for Enhanced Oil Recovery 331

L. Siggel, M. Radloff, S. Reimann, Wintershall Holding GmbH; M. Hansch, M. Nowak, M. Ranft, H. Weiss, E. Schreiner, F. Brand, BASF SE

SPE-169690-MS

Experimental Evaluation of Simultaneous Water and Gas Injection Using Carbon Dioxide 342

S. Shetty, Cairn India Ltd; R.G. Hughes, Louisiana State University; G. Afonja, Occidental Petroleum Corp.

SPE-169691-MS

Low Salinity Waterflooding at West Salym: Laboratory Experiments and Field Forecasts 363

B. Suijkerbuijk, T. Sorop, Shell; A.R. Parker, Shell Global Solutions International; S.K. Masalmeh, Shell Abu Dhabi BV; I.V. Chmuzh, V. Karpan, Y. Volokitin, Salym Petroleum Development; A. Skripkin, NIPINEFT

SPE-169692-MS

Secondary And Tertiary Polymer Flooding On Highly Permeable Reservoir Cores: Experimental Results 372

C. COTTIN, M.J. Bourgeois, R. Bursaux, J. Jimenez, S. Lassalle, Total E&P

SPE-169694-MS

Recovery Factor Estimation in EOR polymerflood project: Field Case 380

F.S. Al-saadi, H.A. Al-Subhi, H. Al-Siyabi, Petroleum Development Oman

SPE-169695-MS

Advanced, High Temperature, Multi-Parameter Coiled Tubing Surveys for Live Thermal Recovery and EOR Well Surveillance 386

M. Padberg, P. Sanders, T. Macdougall, M. Eyre, M. Kamalipour, Petrospec Engineering; P. Sayce, Fotech Solutions

SPE-169697-MS

Alkaline-Free Surfactant Polymer Process for Heavy Oil 398

S. Hocine, A. Magnan, G. Degre, Solvay; N. Rousseau, D. Rousseau, IFP Energies nouvelles

SPE-169698-MS

Study On Air Injection As A Method To Wind Down SAGD Process 409

E. Guo, Y. Jiang, Y. Gao, H. Wang, Research Inst. Petr. Expl/Dev; X. Li, CUG(Beijing); C. Zhigang, Changqing Oil field Company, CNPC



SPE EOR Conference at OGWA

31 March–2 April 2014

Golden Tulip Hotel | Muscat, Sultanate of Oman



Table of Contents (*continued*)

SPE-169699-MS

Degradation (or Lack Thereof) And Drag Reduction Of Hpam During Transport In Pipelines 420

S. Jouenne, J. Anfray, P.R. Cordelier, K. Mateen, D. Levitt, Total E&P; I. Souilem, P. Marchal, L. Choplin, GEMICO-LRGP-ENSIC-Univ. of Lorraine; J. Nesvik, T.E. Waldman, TIORCO, Inc.

SPE-169700-MS

Comprehensive Correlations to Calculate Viscosity of Partially Hydrolyzed Polyacrylamide 434

C. Gao, Sinopec Shengli Oilfield

SPE-169701-MS

Experimental Study on Produced Gas Huff-n-Puff in a Foamy Oil Field 446

S. Xiaofei, Y. Zhang, China University of Petroleum; X. Duan, China University of Petroleum (Huadong); X. Li, Research Institute of Petroleum Exploration and Development, PetroChina

SPE-169702-MS

Novel CO₂ Philic Surfactants for CO₂ Mobility Control for Enhanced Oil Recovery Applications 456

M. Sagir, I. M Tan, M. Mushtaq, M. Nadeem, Universiti Teknologi PETRONAS

SPE-169703-MS

Application of Stream-Line Simulation for Gas Displacement Processes 463

M. Nagib, Saudi Aramco; A. Burns, Energy Technology and Innovation Initiative (ETII), Leeds University; D. Ingham, M. Pourkashanian, Energy Technology and Innovation Initiative (ETII), University of Leeds; A.H. El-banbi, Cairo University

SPE-169705-MS

Colloidal Dispersion Gels (CDG): Field Projects Review 476

E.J. Manrique, TIORCO, LLC; S. Reyes, J.L. Romero, TIORCO LLC; N.M. Aye, M. Kiani, TIORCO, LLC; W.B. North, TIORCO LLC; C.P. Thomas, TIORCO, LLC; M. Kazempour, TIORCO LLC; M. Izadi, TIORCO, LLC; A. Roostapour, TIORCO LLC; G. Muniz, F. Cabrera, M. Lantz, C. Norman, TIORCO, LLC

SPE-169707-MS

The Effects of CO₂ Concentration in Flue Gas Injection for Heavy Oil Recovery from Fractured Reservoirs during GOGD Process 489

A. Mohsenzadeh, M. Escrochi, M. Afraz, G. Karimi, Shiraz University; Y.M. Al-Wahaibi, Sultan Qaboos University; S. Ayatollahi, Shiraz University



Table of Contents (*continued*)

SPE-169708-MS

Experimental and Numerical Investigations into the Effect of Heterogeneity on Heavy Oil Recovery by VAPour EXtraction (VAPEX) 504

M.M. Al-Hadhrani, Imperial College London; A.S. Alkindi, Petroleum Development Oman; A.H. Muggeridge, Imperial College London

SPE-169709-MS

Challenges in 'Surface Facilities Implementation' for a Full Field Polymer Flood Project 525

P. Bhaumik, S. Mohanram, Cairn India Limited

SPE-169711-MS

Performance Evaluation and Design Aspects of Polymer and Hot Water Co-Injection in an Offshore Heavy Oil Field under Challenging Conditions 533

S. Mukherjee, M.P. Suess, Wintershall Holding GmbH

SPE-169713-MS

A Promising ASSP Flooding Technology with Rhamnolipid as Supporting Surfactant 544

C. Lin, Y. Dong, No.2 Oil Production Plant of Daqing Oilfield Company Ltd.; S. Wang, China University of Petroleum (East China); Q. Fang, J. Chen, W. Huang, X. Liu, J. Zhao, B. Li, No.2 Oil Production Plant of Daqing Oilfield Company, CNPC

SPE-169714-MS

Solvent Stimulation to Restore Productivity of Polymer Pattern Producer Wells - A Case Study 553

A.S. Al-kalbani, Petroleum Development Oman; C. Thakuria, Petroleum Development of Oman; K.A. Al-Saqri, C.V. Ravula, B. Choudhuri, K.H. Al-hashmi, Petroleum Development Oman

SPE-169715-MS

Chemical EOR for Heavy Oil: The Canadian Experience 566

E. Delamaide, IFP Technologies Canada Inc.; B. Bazin, D. Rousseau, IFP Energies Nouvelles; G. Degre, Solvay

SPE-169717-MS

Evaluation of Novel Surfactant for Nitrogen-Foam-Assisted EOR in High Salinity Carbonate Reservoirs 597

A.S. Bageri, A.S. Sultan, M.E. Kandil, King Fahd University of Petr. & Min.

SPE-169718-MS

Impact On Crude Dehydration Due To Back Production Of Polymer 609

H. Al Kalbani, G. Philip, H. Al-Hadhrani, M. Al Mandhari, Petroleum Development Oman



Table of Contents (*continued*)

SPE-169719-MS

Treating Back Produced Polymer To Enable Use Of Conventional Water Treatment Technologies 617

H. Al Kalbani, M.S. Mandhari, H. Al-Hadhrami, G. Philip, Petroleum Development Oman; J. Nesbit, SNF Oman; L. Gil, N. Gaillard, SNF Floerger

SPE-169722-MS

Design of Horizontal Polymer Injectors Requiring Conformance and Sand Control 630

M.N. Bouts, M. Rijkeboer, Shell Global Solutions International BV

SPE-169723-MS

Evaluation of Foaming Agents for EOR Application in Carbonate Reservoirs 639

A.B. Fuseni, M. Han, A.A. Aseeri, Saudi Aramco

SPE-169724-MS

Laboratory Study on Polymers for Chemical Flooding in Carbonate Reservoirs 655

M. Han, A.B. Fuseni, B. Zahrani, J. Wang, Saudi Aramco

SPE-169725-MS

Evaluation of Fluorosurfactant Performance with Super-Critical CO₂ Flooding for High Salinity Carbonate Reservoirs 671

Z.Z. Jangda, A.S. Sultan, R.N. Gajbhiye, S.A. Abu-khamsin, A. Arshad, King Fahd University of Petr. & Min.

SPE-169726-MS

Microemulsion Flow in Porous Media: Potential Impact on Productivity Loss 685

M. Izadi, TIORCO LLC, and Colorado School of Mines; H. Kazemi, Colorado School of Mines; M. Kazempour, TIORCO LLC; E.J. Manrique, TIORCO, LLC; N. Rohilla, TIORCO LLC

SPE-169727-MS

Snorre In-depth Water Diversion Using Sodium Silicate - Large Scale Interwell Field Pilot 696

K. Skrettingland, K. Nordaas Kulkarni, O. Fevang, E.I. Dale, V.R. Stenerud, A.M. Lambertsen, Statoil ASA; A. Stavland, Intl Research Inst of Stavanger

SPE-169729-MS

An Innovative Process to Unlock Heavy Oil Resources in a Highly Fractured Carbonate Field 721

S.S. Al-Salmi, Occidental E&P Co.; P.J. Romero, Occidental Oil & Gas Corporation; M.N. Al Balushi, Occidental of Oman Inc.



Table of Contents (*continued*)

SPE-169730-MS

The Novel Use of Deep Eutectic Solvents for Enhancing Heavy Oil Recovery 727

A. Mohsenzadeh, Y.M. Al-wahaibi, R. Al-Hajri, B. Jibril, Sultan Qaboos University

SPE-169731-MS

Improving Condensate Recovery of a Rich Sour Gas Condensate Field by Gas Recycling 750

M. Cobanoglu, F. Khayrutdinov, M. Iqbal, S. Linthorst, Petroleum Development Oman

SPE-169732-MS

Oil Production From Heated Core Plugs: Experimental Results and Thermal Simulation 759

A.P. Van Heel, Petroleum Development Oman; S. Oedai, Shell International Exploration & Production; J.N. Van Wunnik, Petroleum Development Oman

SPE-169734-MS

Polymer-Alternating-Gas Simulation: A Case Study 769

W. Li, Texas A&M University; Z. Dong, Schlumberger Oilfield Services; J. Sun, D.S. Schechter, Texas A&M University

SPE-169736-MS

Permanent Cap-rock Strain Measurement for a Thermal Development 786

J.E. Edwards, M. Seiam, I.S. Mackay, A. keshishian, P. Singh, Schlumberger; A. Sheheimi, S. Bettembourg, Petroleum Development of Oman

SPE-169737-MS

Opportunities and Challenges of Polymer Flooding in Heavy Oil Reservoir in South of Oman 799

G.R. Riethmuller, A.H. Abri, N.S. Al-Azri, G. Stapel, S. Nijman, W.N. Al-Subhi, R.M. Ahmed, Petroleum Development Oman

SPE-169738-MS

CEOR Facilities : Onshore Concept as an Alternative to Offshore 809

I.N. Mahbob, F. Amirrudin, K. Mohamad Othman, F.A. Abd Satar, PETRONAS; N. Halim, PETRONAS Research Sdn Bhd; A.A. Yaacob, PETRONAS; S. Zainal, PETRONAS Research Sdn Bhd

SPE-169740-MS

Polymer Flood at Adverse Mobility Ratio in 2D Flow by X-ray Visualization 820

T. Skauge, B.F. Vik, P. Ormehaug, B.K. Jatten, Uni CIPR - Centre for Integrated Petroleum Research; V. Kippe, I. Skjevraak, D.C. Standnes, K. Uleberg, Statoil ASA; A. Skauge, Uni CIPR - Centre for Integrated Petroleum Research

SPE-169742-MS

Mukhaizna Steam Surveillance Logging 835

R.A. Al Shaibi, A. Al Habsi, W. Al Toqi, Occidental Petroleum; A.S. AL-Hamadani, Occidental of Oman Inc.; A. Al Salmani, Occidental Petroleum



Table of Contents (*continued*)

SPE-169743-MS

Overview and Analysis of a Thermal Trial in a Deep Ultra-Heavy Oil Field in South of Oman 852

R.A. Al Hinai, D.S. Al-Qassabi, N.S. Al-Hinai, A.A. Al-Maharbi, A. Al Bahlani, A.A. Al-Maharbi, N.A. Omairi, A.M. Jahdamy, Petroleum Development Oman

SPE-169744-MS

Rheological Assessment of VES as an EOR Fluid in Carbonate Reservoir 858

M. Sahib, A.S. Sultan, I.A. Hussein, M.A. Mahmoud, King Fahd University of Petr. & Min.

SPE-169745-MS

Construction, Operations and Performance of the First Enclosed Trough Solar Steam Generation Pilot for EOR Applications 866

D.B. Palmer, J.S. Odonnell, Glasspoint Solar

SPE-169746-MS

Optimization of a Large Polymer Flood Using Full-field Streamline Simulation 877

B. Choudhuri, Petroleum Development Oman; C. Thakuria, Petroleum Development of Oman; A. Belushi, Z. Nurzaman, K.H. Al-hashmi, Petroleum Development Oman; R.P. Batycky, Streamsim Technologies, Inc.

SPE-169747-MS

Status of Fluid Flow Mechanisms for Miscible and Immiscible WAG 891

A. Skauge, Ctr for Integrated Petr Research; K.S. Sorbie, Heriot-Watt University

SPE-169890-MS

Cement Evaluation of Fibre-Reinforced Plastic Casing for EOR Observation 906

J.E. Edwards, R. Kalyanaraman, S. Renard, R.V. Kuijk, B.b. Froelich, Schlumberger