

Society of Petroleum Engineers

SPE Reservoir Simulation Symposium 2007

February 26-28, 2007
Houston, Texas, USA

Printed from e-media with permission by:

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

ISBN: 978-1-60423-754-2

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

Copyright and Use Restrictions

Copyright 2007, Society of Petroleum Engineers

Material included in this *Proceedings* is copyright protected. Electronic reproduction, distribution, or storage of any part of an SPE-copyrighted paper for commercial purposes without the written consent of the Society of Petroleum Engineers is prohibited. Permission to reproduce in print is restricted to an abstract of not more than 300 words; illustrations may not be copied. The abstract must contain conspicuous acknowledgment of where and by whom the paper was presented. For photocopying beyond the above permissions, libraries and other users dealing with the Copyright Clearance Center (CCC) Transactional Reporting Service must pay a base fee of \$3 per copyrighted article plus \$0.25 per page to CCC, 222 Rosewood Drive, Danvers, Massachusetts 01923 U.S.A. For other permissions, contact Librarian, SPE, 222 Palisades Creek Drive, Richardson, Texas 75080-2040 U.S.A.

Use of SPE member or author contact information included on this CD for commercial purposes or reproduction of that information in whole or in part, in any form or medium, is strictly prohibited and subject to legal action. Contact SPE to inquire about rental of mailing lists.

This CD of the 2007 SPE Reservoir Simulation Symposium was produced by SPE. This product contains Adobe® Reader® Software. Permission to print and distribute content from this product must be obtained from SPE. Duplication of replication products is absolutely prohibited without written permission from SPE and Adobe. Adobe, the Adobe logo, and Reader are either registered trademarks or trademarks of Adobe Systems Incorporated in the United States and/or other countries.

Material on the CD was reproduced from original papers and/or electronic files provided by the authors. Some discrepancies are inevitable. Please advise SPE of errors so corrections can be made to the electronic versions of the article. Send corrections by e-mail to pdf@spe.org or mail to the SPE Americas Office, attention Technical Paper Administrator.

Society of Petroleum Engineers
SPE Reservoir Simulation Symposium
2007

TABLE OF CONTENTS

A New Production Allocation Optimization Framework	1
<i>B. Guyaguler and T. Byer, Chevron Corp.</i>	
Optimal Waterflood Design Using the Adjoint Method	10
<i>J.F.B.M. Kraaijevanger, Shell Intl. E&P B.V.; P.J.P. Egberts and J.R. Valstar, TNO Built Environment and Geosciences; and H.W. Buurman, LogicaCMG</i>	
An Efficient Algebraic Multigrid Solver Strategy for Adaptive Implicit Methods in Oil Reservoir Simulation	25
<i>T. Clees, Fraunhofer SCAI, and L. Ganzer, SMT Alps</i>	
Adjoint-Based Well-Placement Optimization Under Production Constraints	36
<i>M. Handels and M.J. Zandvliet, Delft U. of Technology; D.R. Brouwer, Shell Intl. E&P; and J.D. Jansen, Delft U. of Technology and Shell Intl. E&P</i>	
Deflation AMG Solvers for Highly Ill-Conditioned Reservoir Simulation Problems	43
<i>Hector Klie and Mary F. Wheeler, U. of Texas at Austin, and Tanja Clees and Klaus Stüben, Fraunhofer Inst.</i>	
Assessing Multiple Resolution Scales in History Matching With Metamodels	52
<i>Adolfo A. Rodriguez, Hector Klie, and Mary F. Wheeler, U. of Texas at Austin, and Rafael Banchs, Polytechnic U. of Catalonia</i>	
Algebraic Multigrid Methods (AMG) for the Efficient Solution of Fully Implicit Formulations in Reservoir Simulation	59
<i>Klaus Stüben and Tanja Clees, Fraunhofer Inst. SCAI, and Hector Klie, Bo Lu, and Mary F. Wheeler, U. of Texas at Austin</i>	
Efficient History Matching and Production Optimization With the Augmented Lagrangian Method	70
<i>D.C. Doublet, S.I. Aanonsen, and X.-C. Tai, Centre for Integrated Petroleum Research, U. of Bergen</i>	
Assessing the Accuracy of History-Match Predictions and the Impact of Time-Lapse Seismic Data: A Case Study for the Harding Reservoir	77
<i>Greg J. Walker, BP plc, and H. Scott Lane, BP America</i>	
Scalability and Load-Balancing Problems in Parallel Reservoir Simulation	85
<i>J.M. Gratien, T. Guignon, J.F. Magras, P. Quandalle, and O. Ricois, IFP</i>	
Efficient Parallel Simulation of CO₂ Geologic Sequestration in Saline Aquifers	91
<i>Keni Zhang, Christine Doughty, Yu-Shu Wu, and Karsten Pruess, Lawrence Berkeley Natl. Laboratory</i>	
Compositional Space Parameterization for Flow Simulation	100
<i>D.V. Voskov and H.A. Tchelepi, Stanford U.</i>	
Event-Targeting Model Calibration Used for History Matching Large Simulation Cases	111
<i>Stig Selberg, Ralf Schulze-Riegert, and Konstantin Stekolschikov, Scandpower Petroleum Technology</i>	

Three-Phase Equilibrium Calculations for Compositional Simulation	118
<i>K.B. Haugen, Yale U.; L. Sun, RERI; and A. Firoozabadi, RERI and Yale U.</i>	
Parallelization on Unstructured Grids	127
<i>Adam Usadi, Ilya Mishev, Jason Shaw, and Klaus Wiegand, Exxon Mobil Upstream Research Co.</i>	
Next-Generation Modeling of a Middle Eastern Multireservoir Complex	136
<i>Bader S. Al-Matar, Ashok Pathak, and Dipak Mandal, Kuwait Oil Co., and John Killough, Graham Fleming, Colin Engle, Nigel Brock, and Sanjeev Varma, Landmark</i>	
A General Unstructured Grid, EOS-Based, Fully-Implicit Thermal Simulator for Complex Reservoir Processes	153
<i>K. Liu and G. Subramanian, ExxonMobil Upstream Research Co.; D.I. Dratler, ExxonMobil Global Services Co.; J.P. Lebel, Imperial Oil Resources; and J.A. Yerian, ExxonMobil Upstream Research Co.</i>	
Data Management in Reservoir Simulation	159
<i>S.C. Gencer, ExxonMobil Upstream Research Co.; B.P. Ketcherside, ExxonMobil Global Services Co.; and G.O. Morrell, E.L. Mulkay, and K.D. Wiegand, ExxonMobil Upstream Research Co.</i>	
A Rapid and Robust Method To Replace Rachford-Rice in Flash Calculations	168
<i>Yinghui Li and Russell T. Johns, U. of Texas at Austin</i>	
Challenges and Solutions in Global-Flow-Based Scaleup of Permeability: Isolated Flow Bodies	180
<i>Matthew T. Stone, Xiao-Hui Wu, Rossen R. Parashkevov, and Stephen L. Lyons, ExxonMobil Upstream Research Co.</i>	
An Ensemble Level Upscaling Approach for Efficient Estimation of Fine-Scale Production Statistics Using Coarse-Scale Simulations	187
<i>Yuguang Chen, Chevron Energy Technology Co., and Louis J. Durlafsky, Stanford U.</i>	
Mixed-Finite-Element and Related-Control-Volume Discretizations for Reservoir Simulation on Three-Dimensional Unstructured Grids	201
<i>S.F. Matringe, Stanford U.; R. Juanes, Massachusetts Inst. of Technology; and H.A. Tchelepi, Stanford U.</i>	
Efficient and Robust Reservoir Model Updating Using Ensemble Kalman Filter With Sensitivity-Based Covariance Localization	214
<i>Deepak Devegowda, Elkin Arroyo-Negrete, and Akhil Datta-Gupta, Texas A&M U., and S.G. Douma, Shell E&P</i>	
A Compositional Streamline Formulation With Compressibility Effects	228
<i>Ichiro Osako and Akhil Datta-Gupta, Texas A&M U.</i>	
Simulation of Surfactant-Aided Gravity Drainage in Fractured Carbonates	246
<i>B. Adibhatia and K.K. Mohanty, U. of Houston</i>	
A Singular Evolutive Interpolated Kalman Filter for Rapid Uncertainty Quantification	252
<i>Baosheng Liang, U. of Texas at Austin; Faruk O. Alpak, Shell Intl. E&P Inc.; and Kamy Sepehrnoori, and Mojdeh Delshad, U. of Texas at Austin</i>	
A New Approach to Automatic History Matching Using Kernel PCA	262
<i>Pallav Sarma, Chevron ETC; Louis J. Durlafsky and Khalid Aziz, Stanford U.; and Wen H. Chen, Chevron ETC</i>	
Multiscale Mixed-Finite-Element Modeling of Coupled Wellbore/Near-Well Flow	281
<i>S. Krogstad, SINTEF ICT, and L.J. Durlafsky, Stanford U.</i>	

Acceleration of Streamline Simulation Using Adaptive Mesh Refinement Along Streamlines	290
<i>Nikolay Andrianov and Kyrre Bratvedt, Schlumberger</i>	
Using the EnKF for Assisted History Matching of a North Sea Reservoir Model	298
<i>G. Evensen, J. Hove, H.C. Meisingset, E. Reiso, K.S. Seim and O. Espelid, Hydro Research Centre</i>	
Practical Iterative Coupling of Geomechanics With Reservoir Simulation	311
<i>P. Samier, Total S.A., and S. De Gennaro, Total U.K.</i>	
Simulating Gravity Drainage and Reinfiltration With a Subdomain-Dual-Permeability Hybrid Fracture Model	321
<i>Barry Rubin, Computer Modelling Group Ltd.</i>	
Coupling Chemical Kinetics and Flashes in Reactive, Thermal and Compositional Reservoir Simulation	330
<i>M.R. Kristensen, Technical U. of Denmark; M.G. Gerritsen, Stanford U.; and P.G. Thomsen, M.L. Michelsen, and E.H. Stenby, Technical U. of Denmark</i>	
Adaptive Multiscale Streamline Simulation and Inversion for High-Resolution Geomodels	342
<i>V.R. Stenerud, Norwegian U. of Science and Technology; V. Kippe, SINTEF ICT; A. Datta-Gupta, Texas A&M U.; and K.-A. Lie, SINTEF ICT</i>	
Effect of Sampling Strategies on Prediction Uncertainty Estimation	357
<i>D. Erbas, Heriot-Watt U. and BP Exploration, and M.A. Christie, Heriot-Watt U. and Edinburgh Collaborative of Subsurface Science and Engineering</i>	
A New IMPSAT Formulation for Compositional Simulation	364
<i>J. Haukas, I. Aavatsmark, and M. Espedal, U. of Bergen, and E. Reiso, Norsk Hydro Oil & Energy Research Centre</i>	
Parallel Unstructured Solver Methods for Complex Giant Reservoir Simulation	372
<i>Larry S.K. Fung and Ali H. Dogru, Saudi Aramco</i>	
A Method To Improve the Mass Balance in Streamline Methods	380
<i>Vegard Kippe, SINTEF; Hakon Haegland, U. of Bergen; and Knut-Andreas Lie, SINTEF</i>	
Operator-Based Multiscale Method for Compressible Flow	392
<i>H. Zhou and H.A. Tchelepi, Stanford U.</i>	
Field Development Optimization Technology	400
<i>Michael Litvak, Brian Gane, Glyn Williams, Mark Mansfield, Patrick Angert, Chris Macdonald, Lesley McMurray, Roger Skinner, and Greg J. Walker, BP</i>	
A Rigorous Pore-to-Field-Scale Simulation Methodology for Single-Phase Flow Based on Continuous Time Random Walks	410
<i>Matthew E. Rhodes, Branko Bijeljic, and Martin J. Blunt, Imperial College London</i>	
A New Finite-Volume Approach to Efficient Discretization on Challenging Grids	418
<i>I. Aavatsmark, G.T. Eigestad, and B.-O. Heimsund, CIPR; B.T. Mallison, Chevron; J.M. Nordbotten, U. of Bergen; and E. Oian, CIPR</i>	
A Mimetic Finite-Volume-Discretization Operator for Reservoir Simulation	427
<i>Faruk O. Alpak, Shell Intl. E&P Inc.</i>	
Efficient Permeability Parameterization With the Discrete Cosine Transform	444
<i>B. Jafarpour and D.B. McLaughlin, Massachusetts Inst. of Technology</i>	
A New Multipoint Flux Approximation for Reservoir Simulation	453
<i>Qian-Yong Chen, U. of Massachusetts Amherst, and Jing Wan, Yahan Yang, and Rick T. Mifflin, ExxonMobil Upstream Research Co.</i>	

Unstructured Upgridding and Transmissibility Upscaling for Preferential Flow Paths in 3D Fractured Reservoirs	462
<i>S. Vitel and L. Souche, Ecole Natl. Supérieure de Géologie</i>	
Quasimonotonic Continuous Darcy-Flux Approximation for General 3D Grids of Any Element Type	473
<i>Mayur Pal and Michael G. Edwards, U. of Wales</i>	
Parallel Automatically Differentiable Data-Types for Next-Generation Simulator Development	487
<i>R.M. Younis and K. Aziz, Stanford U.</i>	
Author Index	