

# **SPE Western Regional Meeting 2024**

Palo Alto, California, USA  
16 - 18 April 2024

Volume 1 of 2

ISBN: 978-1-7138-9705-7

**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© (2024) by Society of Petroleum Engineers  
All rights reserved.

Printed with permission by Curran Associates, Inc. (2025)

For permission requests, please contact 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](mailto: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: 845-758-2633  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

# TABLE OF CONTENTS

## VOLUME 1

### **DIGITAL TECHNOLOGIES FOR FIELD OPTIMIZATION**

Labeling Job Type and Technology for Large Operational Datasets .....	1
<i>S. Hassig Fonseca, A. Jan, K. Prokopetc, E. Ugarte, N. Vodnikov, P. Spesivtsev, P. Ramondenc, L. Venkataramanan</i>	
A Real Time Cloud-Based Transient Modeling of Wellbore Fluids Enabling Safer Deep Transient Testing .....	20
<i>Velerian Sanjao Lopes, Arvind Kumar, Poorna Venkata Sai Teja Nukala, Tety Benedicta Wydiabhakti</i>	
Advancing Digital Rock Imaging with Generative Adversarial Networks.....	35
<i>Cenk Temizel, Uchenna Odi, Coskun Cetin, Yusuf Pamukcu</i>	

### **WELL EVALUATION AND INTERVENTION**

Investigation of Coupled Wellbore Temperature, Pressure, and Stress Response in Stage-By-Stage Hydraulic Fracturing .....	44
<i>Yongfeng Kang, Robello Samuel, Zhengchun Liu, Adolfo Gonzales</i>	
Advanced Realtime Early Kick and Loss Detection (EKLD) Through a Hybrid Data-Driven and Physics-Constrained Approach.....	58
<i>Shang Zhang, Robello Samuel</i>	
Efficient and Sustainable Scale Removal: Unveiling the Power of Pressure Pulsing in Restoring Wellbore Accessibility.....	68
<i>H. S. Aljauydi, S. X. Mehmood, B. M. Aljuaid, A. H. Abouakar</i>	
Engineered High Performance Water Based Mud Application and Integrated Geo-Mechanics Help Drill Through Challenging Shale Formation with Record ROP in the Fold Belt Kirthar Concession – A Case Study from Pakistan .....	80
<i>Muhammad Azhar Hussain, Syed Asad Abid, Muhammad Azeem Sarwar, Sucklaj Shahid, Hammad Ahmad, Ihtesham Ul Wahab, Michal Makos, Mateusz Gorniak, Syed Shehzad Haider</i>	

### **RESERVOIR ENGINEERING - LOW SALINITY WATER FLOODING**

Experimental Investigation of Waterflood Performance Challenges in a Low-Permeability Morrowan Sandstone Reservoir: Implications for Mechanistic Modeling and Enhanced Oil Recovery Optimization.....	100
<i>A. Morgan, W. Ampomah, R. Grigg, S. Wang, R. Czarnota</i>	
Improving the Performance of Smart Waterflooding Through Surfactant-Assisted Process for a Carbonate Oil Reservoir .....	120
<i>Ahmed Fatih Belhaj, Shasanowar Hussain Fakir, Amir Hossein Javadi, Hemanta Kumar Sarma</i>	

Descriptive Statistical Analysis of Experimental Data for Wettability Alteration with Smart Water Flooding in Carbonate Reservoirs .....	134
<i>Muhammad Ali Buriro, Mingzhen Wei, Baojun Bai, Ya Yao</i>	

Geochemical Modeling of Low Salinity Polymer Flooding for Carbonate Rocks .....	159
<i>Aaron Guadalupe Tellez Arellano, Emad W. Al-Shalabi, Anas M. Hassan, Muhammad S. Kamal, Shirish Patil, Syed M. Shakil Hussain</i>	

### **APPROACHES TO USING MACHINE LEARNING WITHIN UPSTREAM**

Improving ESP Production for Unconventional Wells Through Real-Time Machine Learning Based Changepoint Detection .....	186
<i>Y. Hamed Shokrlu, J. Bazile</i>	

Enhancing Pressure Transient Analysis with Automatic Model Identification: A Machine Learning Approach .....	201
<i>S. T. Nukala, A. Kumar, S. Rajput, V. S. Lopes, T. B. Wydiabhakti</i>	

Effective Production Forecasting and Robust Rate Optimization Using Physics Informed Neural Networks .....	209
<i>Han Meng, Ruxin Zhang, Botao Lin, Yan Jin</i>	

Enhancing Continuous Well Flow Rates Estimation with Ensemble Machine Learning Models .....	231
<i>V. Martinez</i>	

Formation Evaluation and Behind Casing Opportunity Analysis Using Multi-Output Regression and Machine Learning Techniques .....	245
<i>H. Hassani, A. Shahbazi, M. Z. Fadhli, Z. Hamdi, A. M. Hassan, R. Masoudi, M. Bataee</i>	

Reservoir Properties Estimation Using Flow Zone Indicator and Artificial Neural Network Integration: A Case Study .....	259
<i>Z. Hamdi, I. Ahmed, A. M. Hassan, M. Bataee</i>	

Machine Learning Models to Predict Total Skin Factor in Perforated Wells .....	277
<i>S. Thabet, A. Elhadidy, M. Elshielh, A. Taman, A. Helmy, H. Elnaggar, T. Yehia</i>	

Machine Learning Models to Predict Production Rate of Sucker Rod Pump Wells.....	289
<i>S. Thabet, H. Zidan, A. Elhadidy, A. Taman, A. Helmy, H. Elnaggar, T. Yehia</i>	

### **ROLE OF CCS AND RENEWABLES IN GETTING TO NET ZERO**

What will it take to get to Net-Zero Emissions in California? .....	299
<i>Joshua Neutel, Andrew Berson, Sarah Saltzer, Franklin Orr, Adam Brandt, Sally Benson</i>	

Long-Term Wind Energy Production from Shallow Water Offshore Platforms Destined for Removal .....	341
<i>Ziyang Song, Iraj Ershaghi</i>	

The Green Energy Conundrums .....	356
<i>James W Earhart, Stuart Neblett</i>	

Fluid Migration Along Faults: Implications for CCUS .....	366
<i>J. D. Zhou, P. Likanapaisal, L. S. Lun, P. Krishnamurthy</i>	

A Reinforcement Learning Approach to Optimize CO2 Removal from Flue Gas in Carbon Capture Applications.....	383
<i>M. Zirrahi, C. Santiago, K. MacFarlan</i>	
Carbon Sequestration in Mid Ocean Ridge Hydrothermal Systems.....	393
<i>Gregory D. Croft</i>	
Numerical Investigation of CO2 Convective Transport in Stochastically Generated Heterogenous Media: Implications for Long-Term CO2 Sequestration in Saline Aquifers .....	399
<i>Md Fahim Shahriar, Aaditya Khanal</i>	

## **INNOVATIONS AND CASE STUDIES**

Monitoring Low and Intermittent Methane Emission from Orphaned and Idle wells.....	409
<i>Nima Daneshvarnejad, Pooya Khodaparast, Young Cho, Donald Paul, Mike Hauser, Shahram Farhadi, Iraj Ershaghi</i>	
Successful Perforation of Fiber Glass Casing for the 1st Time in KOC to Convert Idle Observation Well to Producer, A Case Study.....	418
<i>S. Matar, R. Kurma, W. Al-Fadhli, M. C. Shastri, M. Muthafar, M. Yaser</i>	
Improving Production and Hydrocarbon Recovery from Viscous Oil Reservoirs in Ecuador While Minimizing the Carbon Intensity of Production Using AICD Technology .....	431
<i>Michael Konopczynski, Martina Grefa, Martha Castillo, Angel Villavicencio, Maurilio Solano, Arlen Chanaga</i>	

## **RISK AND REGULATION**

Advancements in Gas Field Operations: A Path to Achieving Zero Flaring .....	446
<i>Zaid Alsuhali, Meshal Amry</i>	
Digital Decarbonization in the Oil and Gas Industry .....	452
<i>Iraj Ershaghi, Donald L. Paul, Andrei Popa</i>	
The Integrity of Idle and Abandoned Wells in California.....	463
<i>M. Rehak, D. Warburton, N. Daneshvarnejad, I. Ershaghi</i>	
Determination of Optimal Corrosion Logging Frequencies for Gas Storage Fields.....	475
<i>K. Abaa, H. Tripathi</i>	
Chemical Reduces Risk of Stuck Pipeline Cleaning Equipment in Deepwater Subsea Flowlines.....	496
<i>R. X. Rodriquez, S. A. Bufton, T. J. Blanchard, R. Schuttler</i>	

## **DATA-DRIVEN AND DEEP LEARNING CASE STUDIES**

A Data-Driven Journey into Liquid Loading Detection and Prediction .....	510
<i>Utkarsh Sinha, Prithvi Singh Chauhan, Hardikkumar Zalavadia, Arsalan Adil, Sathish Sankaran</i>	
Deep Learning-Based Segmentation for Quartz Overgrowth Quantification in Geothermal Sandstone Reservoirs from Scanning Electron Microscope (SEM) Images.....	529
<i>Sarah Sausan, Arkanu Andaru</i>	

## VOLUME 2

MWD Tools' Electronic Components Data-Driven Failure Detection .....	543
<i>A. Rodriguez, C. Rey-Torres, A. Kohar, A. Malik</i>	
Condition-Based Maintenance of Oilfield Cement Pumper: A Data-Driven Approach .....	550
<i>J. J. Duarte, S. Vaithianathan, D. K. Mohan, M. Nakamura, M. Soin, N Tilakpure, D. Tan, A. Kohar</i>	
Prediction of Surfactant Performance from Surfactant Huff-Puff in Carbonate Reservoirs Using a Data-Driven Approach and Desktop Application Development.....	561
<i>Y. Yao, M. Wei, Y. Cui, M. Ali, J. Leng, Y. Qiu</i>	

### **UNCONVENTIONAL RESOURCES**

Effect of Stress and Thermal Deformation Modes on Correlation of Permeability of Naturally Fractured Sandstone and Shale Formations.....	572
<i>Faruk Civan</i>	
An Analysis of Effect Different Fracturing Fluids on the Productivity of Multi-Stage Fractured Marcellus Shale Horizontal Wells .....	598
<i>Mohammed. El Sgher, Kashy. Aminian, Samuel. Ameri</i>	

### **GEOHERMAL RESOURCES**

Integrate Carbon Sequestration in Enhanced Geothermal System Through Surface Dissolution .....	606
<i>G. Zhang, J. Norbeck, A. Smith, S. Dadi, G. E. Galban</i>	
Repurposing Idle Wells for Low-Temperature Geothermal Water .....	624
<i>Qianru Qi, Mariam Tapsoba, Iraj Ershaghi</i>	
Boosting the Performance of Geothermal Wells Using Progressively-Burning Propellant and High-Rate Acidizing .....	636
<i>H. Aydin, C. Junesompitsiri, F. Hunkar, JD Schmidt, R. Schmidt, A. Schmidt</i>	
Predicting Future Heat Outputs from Enhanced Geothermal System Utilizing Machine Learning Approach.....	646
<i>Fatick Nath, Nora A Garcia Romero, Eleazar Cabezudo, Shaon Sutradhar, Erik Cisneros, Orlando Portillo, Ronen Gindic</i>	
Challenges and Recent Advances in Modeling and Simulation of Geothermal Systems .....	656
<i>Cenk Temizel, Uchenna Odi, Coskun Cetin, Yusuf Pamukcu, Cengiz Yegin</i>	

### **HYDROGEN**

Investigation on the Impact of Cushion Gases in Saline Aquifer: Implication for Underground H <sub>2</sub> Storage.....	674
<i>Rana AL homoud, Marcos Vitor Barbosa Machado, Hugh Daigle, Kamy Sepehrnoori, Harun Ates</i>	
Hydrogen Storage in Saline Aquifers: Experimental Observations of Viscous-Dominated Flow .....	692
<i>J. D. Zhou, A. R. Kovscek</i>	

Numerical Investigation of Hydrogen Storage Loss in Saline Aquifers .....	704
<i>A. Khanal, M. I. Khan, M. F. Shahriar</i>	
Impact of Wettability and Relative Permeability Hysteresis in Saline Aquifers; Implication of Hydrogen Underground Storage.....	717
<i>Rana AL homoud, Marcos Vitor Barbosa Machado, Hugh Daigle, Kamy Sepehrnoori, Harun Ates</i>	
Mechanisms of Hydrogen Generation During In-Situ Combustion Gasification of Heavy Oil .....	732
<i>Mohamed Amine Ifticene, Qingwang Yuan</i>	
Techno-Economic Evaluation of Turquoise Hydrogen and Carbon Nanotubes Integration in Oil and Gas Infrastructure .....	744
<i>I. F. Joao</i>	
Maximizing Hydrogen Yield: Pioneering Gas Injection for Enhanced Light Oil Reservoir Utilization.....	766
<i>Chinedu J. Okere, James J. Sheng, Princewill M. Ikpeka</i>	

### **RESERVOIR ENGINEERING - MODELING AND MONITORING**

Fractal Approach for Naturally Fractured Reservoirs Characterization Using Reservoir Simulation .....	777
<i>C. F. Silva-Escalante, R. G. Camacho-Velazquez</i>	
Application of Streamlines in Natural Depletion Systems .....	789
<i>R. Tovar</i>	
Enhanced Reservoir Parameter Redistribution in Single Well Reservoir Modeling: An Inversion Approach Using Pressure Transient Analysis Data .....	799
<i>Arvind Kumar, Tety Benedicta Wydiabhakti, Sai Teja Nukala, Velerian Sanjao Lopes, Keka Ojha</i>	

### **CARBON CAPTURE, UTILIZATION AND STORAGE**

Parametric Study of CO <sub>2</sub> Sequestration in Deep Saline Aquifers Using Data-Driven Models.....	808
<i>M. I. Khan, A. Khanal</i>	
3-D Leakage and Seismic Hazard Assessment for a Potential CO <sub>2</sub> Storage Site in the Southern San Joaquin Basin, CA.....	821
<i>A. Kohli, T.W. Kim, Y. Li, A. R. Kavscek</i>	
Experimental Investigations of Caprock Integrity for Geological Carbon Storage Using Three-Dimensional Digital Image Correlation.....	834
<i>F. Nath, E. Cabezudo, N. G. Romero</i>	
Optimizing Injection Well Trajectory to Maximize Storage Security and Minimize Geomechanical Risk.....	848
<i>Y. Li, R. ONeal, M. Whitezell, A. R. Kavscek</i>	
Spatial Monitoring of Geological Carbon Storage Progress Using Time-Lapse Satellite Images.....	867
<i>Y. Li, N. Dodds, P. Leezenberg, A. R. Kavscek</i>	
Numerical Simulation of CO <sub>2</sub> Storage in the Soft Sediments of Depleted Reservoirs in the Gulf of Mexico.....	885
<i>Sam S Hashemi, Anthony Kavscek</i>	

A Novel Approach to Foam Characterization Using Multi-Frequency Dielectric Technique for Enhanced Oil Recovery .....	904
<i>Ahmed Bashir, Amjed Hassan, Hussein Attia, Shirish Patil, Muhammad Shahzad Kamal, Ammar El-Husseiny, Mohamed Mahmoud</i>	
Adapting Oilfield Operational Strategies for Optimizing Injectivity in Complex CCS Systems – A Scoping Study.....	916
<i>P. Ravi Ganesh, J. Hershberger, T. Vance, S. Skopec, S. Chundur, M. Kelley, N. Gupta</i>	
Exploration of CO <sub>2</sub> -Sensitive Chemicals as Potential Sealing Agents for Subsurface CO <sub>2</sub> Storage.....	933
<i>L. Quan, M. Mirabolghasemi</i>	

## **ENHANCED OIL RECOVERY**

Experimental Studies of Sulfonated Polymer Adsorption in Carbonates Under Challenging Conditions .....	945
<i>Ahmad Mahboob, Anas M. Hassan, Sarmad Z. Khan, Anoo Sebastian, Muhammad Mushtaq, Emad W. Al-Shalabi, Mursal Zeynalli</i>	
Characterization and Evaluation of Novel Zwitterionic Surfactants for Enhanced CO <sub>2</sub> Foam for CO <sub>2</sub> Sequestration in Saudi Arabian Reservoirs .....	958
<i>Ahmed Bashir, Ahmad Mahboob, Syed M. Shakil Hussain, Shirish Patil, Muhammad Shahzad Kamal, Xianmin Zhou</i>	
Research on Performance Evaluation and Mechanism Analysis of a Novel Nano Oil-Displacement System .....	968
<i>Jian Zhang, Zhe Sun, Xiujun Wang, Jie Cao, Valentina V. Vasilevskaya, Alexandra Ushakova</i>	
Technical Assessment of Temporary Gas Storage to Avoid Flaring: A Case Study .....	988
<i>Ala Eddine Aoun, Olusegun Tomomewo, Mohamed Cherif Ben Ameer, Mohammad Masadeh, Youcef Khetib</i>	

## **RESERVOIR CHARACTERIZATION**

Temperature Warmback Test Design and Interpretation in Presence of Long Injection History .....	1004
<i>M. Zeidouni, H. Kohzadi, M. Zamehrian</i>	
Advancing Reservoir Understanding: Integrating Deep Learning into Automated Formation Micro-Imaging Log Interpretation for Enhanced Reservoir Characterization and Management .....	1019
<i>Amr Gharieb, Mohamed Adel Gabry, Mohamed Elsayy, Ahmed Algarhy, Ahmed Farid Ibrahim, Nihal Darraj, M. R. Sarker, Ahmed Elshaafie</i>	
Application of Cole Plot to Better Estimate Reserves in a Complex, Multi Layered, Water Drive Gas Reservoir .....	1033
<i>Wulandari Tamara</i>	
Applied Machine Learning for the Imputation of Missing Core Petrophysical Property Data in Clastic and Carbonate Reservoirs.....	1046
<i>Hussein B. Abdulkhaleq, Watheq J. Al-Mudhafar, David A. Wood, Sarah Sausan</i>	
Data Analytics and Machine Learning Application for Reservoir Potential Prediction in Vuggy Carbonate Reservoirs Using Conventional Well Logging .....	1063
<i>Amr Gharieb, Mohamed Adel Gabry, Mohamed Elsayy, Ahmed Algarhy, Ahmed Farid Ibrahim, Nihal Darraj, M. R. Sarker, Samuel Adel</i>	



Classification and Evaluation of Microscopic Pore Structure in Carbonate Rocks by Integrating  
MICP-Based Dynamic Information..... 1074  
*Muyuan Wang, Kelu Wu, Zhangxin Chen, Jing Li, Dong Feng*

**Author Index**