



CNPC R&D (DIFC) Company Limited

# CNPC R&D Symposium: Waterflooding Sweep Efficiency Enhancement

14-15 November 2023

Le Royal Méridien Beach Resort & Spa  
Dubai, U.A.E.

[www.cnpcrd.com](http://www.cnpcrd.com)

## Symposium Program



## Message from the CEO of CNPC R&D

Welcome to CNPC R&D Symposium,

The Symposium is about the future. It is collaborative, idea-generating in informal format that stimulate new ideas and innovation to meet upcoming challenges to the Oil & Gas E&P industry.

The Symposium format is intended to create an atmosphere that encourages the open exchange of thoughts and views among all participants. The CNPC R&D Symposium is "off-the-record", the presentations are Confidential and extensive notetaking is prohibited.

An event that brings together top technologists, innovators from IOCs, NOCs, SOCs and Academia to address specific industry challenges.

Speakers present what they did, the results of their actions, talk about current best practices and technologies used in the field now and their conclusions based on those results.

Experts are invited to participate in 2 days of the future and how to shape it. The Symposium is international in scope, drawing technical leaders worldwide.

The Symposium is limited attendance to 100 invited participants who are encouraged to contribute actively to all sessions. To be invited to attend the CNPC R&D Symposium is a clear indication that the invitee is recognized as an expert or future thought leader on the subject. The Symposium Round Table gather the best minds to exchange thoughts and views and produce revelations and new ways of looking at things that could not otherwise be achieved. Participants focus on where the technology needs to go, generate ideas, and have peer-to-peer discussion.

The Symposium provide opportunities for networking outside the session room through social events, joint meals, and breaks.

Participants are expected to attend the full duration of the Symposium.

Looking forward to seeing you in our Symposium.



**Dr. Zewu Lai**  
Chief Executive Officer



## CNPC R&D (DIFC) Company Limited

### About CNPC R&D

World-class technical center providing optimized solutions for sustainable energy development.

Integrated organization, covering the entire upstream technical disciplines: Subsurface, Wells and Facility Engineering.

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# CNPC at a glance (2022 figures)

**\$485,7bn**  
Revenue

**\$25,765bn**  
Earning

**\$358,4bn**  
Market Capitalization

**Oil  
Production**

**3.7 mbd**

**Gas  
Production**

**177 bcm**

**R&D  
Expenditures**

**\$4.241 bn**



Research institutes

**95**

Key laboratories and testing bases

**56**

National R&D and innovation platforms

**14**



# Organizing Committee

## Co-Chair



**Mr. David D. Smith**  
President and  
Principal Advisor  
Oilfield Conformance  
Consulting LLC



**Prof. Dr. Baojun Bai**  
Program Head, Petroleum  
Engineering Director, Particle Gel  
Conformance Control Consortium  
Missouri University of Science and  
Technology

## Committee Members



**Dr. Xinmin Song**  
Chief Geoscientist, CNPC R&D  
Director, China State Key  
Laboratory of Enhanced Oil  
Recovery



**Mr. Ahmed Sharif**  
Senior Reservoir Engineer  
Schlumberger Ltd.



**Dr. Guilin Luan**  
Chief Advisor/  
Acting Technical VP  
CNPC R&D



**Dr. Mohammed Saad  
Al Kobaisi**  
Associate Professor  
Khalifa University of Science  
and Technology



**Mr. Flavien Maire**  
Senior Specialist, Reservoir  
Engineering, Subsurface  
Excellence Division  
ADNOC Thamama Center



**Mr. Carlos Mascagnini**  
Petroleum Engineering Lead  
Baker Hughes



**Dr. Omar Al-Farisi**  
AI Senior Technology Advisor  
to CTO Dragon Oil





# Speakers

## Operators



**Dr. Li Yong**  
Vice President

**Dr. Cui Longlian**  
Overseas Engineering  
Director



**Mr. Saleh Ali Al Sayari**  
Team Leader

**Dr. Kristian  
Mogensen**  
Senior EOR Specialist

**Mr. Dorzhi Badmaev**  
Sr. Specialist in Cognitive  
Reservoir Management



Dragon Oil

**Dr. Omar Al-Farisi**  
AI Senior Technology  
Advisor to CTO



شركة تنمية نفط عمان  
Petroleum Development Oman

**Ms. Aisha Bimani**  
PDO RE Discipline  
Coach - ATP

## Services Companies



CNPC R&D (DIFC) Company Limited  
中国石油迪拜研究院

**Dr. Song Xinmin**  
Chief Geoscientist

**Mr. Wang Yucai**  
Chief Engineer

**Mr. Liu Huifeng**  
Principal Well Engineer



Oilfield  
Conformance  
Consulting LLC

**Mr. David Smith**  
President

**HALLIBURTON**

**Mr. Giuseppe Ambrosi**  
Technical Manager

**Schlumberger**

**Mr. Jobin Cherian**  
Reservoir Simulation  
Engineer

**Mr. Coriolan Rat**  
Team Lead

**Mr. Syed Aamir Aziz**  
Production and Well  
Integrity Engineer



**Mr. Carlos Sirlupu Ruiz**  
Production Advisor

## Academia



**Dr. Baojun Bai**  
Professor



**Dr. Hu Guo**  
Professor



**Dr. Ben Shiau**  
Associate Professor



**Dr. Ibelwaleed  
Ali Hussein**  
Professor



# Participants

## Operators



## Services Companies



## Academia



# About CNPC R&D's Carbonate Reservoirs Waterflooding Sweep Efficiency Control Symposium

More than half of the world's recoverable oil resources are concentrated in the Middle East, primarily within carbonate reservoirs.

Waterflooding has been widely used to improve the recovery factor from carbonate reservoirs to around 35% on average.

However, the sweep efficiency of waterflooding processes is significantly impacted by the development strategy, operation issues, and the typical challenges arising from carbonate reservoirs:

- The high heterogeneities
- The mineral compositions of the carbonate rocks
- The water channeling features

CNPC, increasingly active in developing Middle Eastern oilfields, has first-hand experience dealing with waterflooding challenges. Given our focus on carbonate reservoirs, we recognize the urgency of addressing these challenges.

CNPC R&D, the technical center of CNPC in the Middle East, is organizing a symposium to bring together experts and decision makers from around the globe. The goal is to exchange insights on enhancing the sweep efficiency of waterflooding operations and boosting recovery factors.

- As operator: you will hear challenges, lessons learned and best practices.
- As service provider: you can present your technologies and solutions.
- As research professional: you can inform about the latest innovation and breakthrough technologies.

This 2-day symposium is planned in the form of technical plenary sessions and roundtable discussions to maximize the benefits:

- Day 1 and the morning of Day 2 will consist of plenary sessions divided into eight categories.
- Day 2 afternoon will feature a roundtable discussion, focusing on the most relevant waterflooding challenges.

Join us as we collaborate, innovate, and harness the untapped potential of waterflooding in carbonate reservoirs.

## Session Highlights

- **Maximize the period and oil recovery of water-free and low water-cut production through optimized development planning, catering for active waterflooding sweep efficiency control as the main focus and dealing with water problems as supplementary measures.**
- **Candidate Selection and Problem Understanding**
- **Wellbore Intervention Solutions**
  - Mechanical methods to control sweep efficiency
  - Chemical methods to control sweep efficiency
  - Cements and VSF methods to enhance sweep efficiency
  - Well stimulation while maintaining sweep efficiency
- **AI and machine learning for Improving Sweep Efficiency**

## Attendees:

Professionals involved in:

- Petroleum Engineering Managers
- Petroleum Engineers
- Completion and Production Engineers
- Geoscientists
- Researchers in Academia
- Service providers in Waterflooding Sweep Efficiency Control

# Program Quick View

## Tuesday, 14 November 2023

|               |  |
|---------------|--|
| 08:00 - 08:50 | Arrival of Participants  |
| 08:50 - 09:00 | Safety Moment  |
| 09:00 - 09:10 | A message from CNODC   |
| 09:10 - 09:15 | Welcome Remarks  |
| 09:15 - 09:25 | Keynote Address  |
| 09:25 - 10:25 | Session 1: Opening   |
| 10:25 - 10:40 | Coffee and Tea Break   |
| 10:40 - 12:10 | Session 2: Reservoir Characteristics Based Waterflooding Design  |
| 12:10 - 13:10 | Session 3: From Monitoring in Injectors and Producers to Candidate Selection and Problem Understanding |
| 13:10 - 14:10 | Prayer and Lunch   |
| 14:10 - 15:10 | Session 4: Wellbore Interventions Solutions: Mechanical Methods to Control Sweep Efficiency            |
| 15:10 - 15:40 | Coffee and Tea Break   |
| 15:40 - 17:40 | Session 5: Wellbore Interventions Solutions: Chemical Methods to Control Sweep Efficiency              |
| 18:00 onwards | Welcome Dinner, sponsored by Schlumberger  |

## Wednesday, 15 November 2023

|               |  |
|---------------|--|
| 07:00 - 08:00 | Arrival of Participants  |
| 08:00 - 08:15 | Safety Moment  |
| 08:15 - 09:15 | Session 6: Wellbore Interventions Solutions: Cements and VSF Methods to Control Sweep Efficiency     |
| 09:15 - 10:15 | Session 7: Well Stimulation while Maintaining Control of Sweep Efficiency                            |
| 10:15 - 10:30 | Coffee and Tea Break   |
| 10:30 - 12:00 | Session 8: Computational methods including AI and data-driven approaches to improve Sweep Efficiency |
| 12:00 - 13:00 | Prayer and Lunch   |
| 13:00 - 16:00 | Round Table Session: Key Challenges and Solutions to Solve Sweep Efficiency Problems                 |
| 16:00 - 17:00 | Summary and Closing Remarks  |





# Technical Program (as of 07 Nov 2023)

**Tuesday, 14 November 2023 | 08:00 - 08:50**

Arrival of Participants

**Tuesday, 14 November 2023 | 08:50 - 09:00**

Safety Moment

**Tuesday, 14 November 2023 | 09:00 - 09:10**

**A message from CNODC:** Mr. Wenyuan He, General Manager, CNODC

**Tuesday, 14 November 2023 | 09:10 - 09:15**

**Welcome Remarks:** Dr. Zewu Lai, CEO, CNPC R&D

**Tuesday, 14 November 2023 | 09:15 - 09:25**

**Keynote Address:** Dr. Xudong Jing, ADNOC Vice President, Subsurface Excellence

**Tuesday, 14 November 2023 | 09:25 - 10:25**

## Session 1: Opening

In this opening session, our keynote speaker, Dr. Song Xinmin, professor and chief geoscientist of CNPC R&D, is going to share his strategy on how to maximize the waterflooding efficiency through structured approach from field development planning, well design and production strategy, catering for “active” sweep efficiency control as the main focus and dealing with waterflooding problems as the supplementary measures. Our Co-Chair, Mr. David Smith will provide his insights on the critical elements required to effectively solve waterflooding sweep efficiency problems. Both presentations will challenge us to maintain focus on clear strategy for waterflooding development design and solving the appropriate problem through understanding of the connection between root causes and effective solutions to improving sweep efficiency in the waterflooding projects.

Water Injection Development and Water Control Strategy for Carbonate Reservoirs

Conformance Engineering – Overview of the process approach to solving sweep efficiency problems

Dr. Song Xinmin  
Chief Geoscientist  
CNPC R&D

**Tuesday, 14 November 2023 | 10:25 - 10:40**

**Coffee and Tea Break**

Mr. David Smith  
President  
Oilfield Conformance  
Consulting LLC



# Technical Program (as of 07 Nov 2023)

Tuesday, 14 November 2023 | 10:40 - 12:10

## Session 2: Reservoir Characteristics Based Waterflooding Design

In this session, our speakers will discuss the methods of improving water distribution within and across reservoir formations and layers, as well as achieving a high areal sweep efficiency. The pursuit of these goals encompasses several strategies, from optimized Field Development Plans (FDPs), pattern reorientation or redistribution, custom pattern orientations, to infill drilling and sidetracks. Enhanced Oil Recovery (EOR) methods designed to alter residual oil saturation, such as surfactant flooding, CO<sub>2</sub> or miscible flooding will not be covered; while polymer flooding to address mobility control with some influence on permeability alteration across the entire field will be discussed. Discreet utilization of chemical methods will be covered in Session 5, Chemical to Control Sweep Efficiency.

|  |   |
|--|---|
| PDO Waterflood Gap to Potential focus Area and Key deliverables  | Ms. Aisha Bimani<br>RE Discipline<br>Coach - ATP<br>PDO |
| Carbonate Reservoir re-development leveraging on down spacing and long horizontal                              | Mr. Saleh Ali Al Sayari<br>Team Leader<br>ADNOC RE      |
| Water injection Development of Carbonate Reservoirs: Situation, Challenge and Corresponding Technical Measures | Dr. Li Yong<br>Vice President<br>CNPC-RIPED             |

Tuesday, 14 November 2023 | 12:10 - 13:10

## Session 3: From Monitoring in Injectors and Producers to Candidate Selection and Problem Understanding

This session will focus on the importance of designing and executing proper diagnostics to generate a complete understanding of the sweep efficiency or conformance problem. This includes a focus on monitoring the movement of the injected and produced water which is critically important in the various phases of the field development, e.g., appraisal, piloting, development plan execution and production operation, providing the basis for proactive water control measures. The monitoring and testing can be done around wellbores and in the reservoir formations, which requires different technologies, tools, and operating procedures. This session will discuss methods, experiences, and best-practices in water monitoring and how this knowledge can be used to understand sweep efficiency problems.

|  |   |
|--|---|
| Diagnostic Approaches for Water Cut Problems in the Middle East  | Mr. Liu Huifeng<br>Principal Well Engineer<br>CNPC R&D                |
| Integrated Approach of Water Breakthrough and flood monitoring in carbonate reservoir - examples explained | Mr. Syed Aamir Aziz<br>Production &<br>Well Integrity Engineer<br>SLB |

Tuesday, 14 November 2023 | 13:10 - 14:10

Prayer and Lunch



# Technical Program (as of 07 Nov 2023)

Tuesday, 14 November 2023 | 14:10 - 15:10

## Session 4: Wellbore Interventions Solutions: Mechanical Methods to Control Sweep Efficiency

Mechanical water control methods have been used for many decades to assist control of the near wellbore flow dynamics and improve sweep efficiency. In recent years, they have seen increased use in the Middle East to optimize the production/injection profiles along horizontal wells. Mechanical control of the wellbore can be designed for permanent control or temporary control to assist in the placement of other products. Mechanical control tools can also be utilized during the completion to offer a method for proactive or reactive water shut-off after breakthrough. These systems are generally termed "Smart Well" technologies and will be covered here. This session will discuss challenges, case studies, best practices, and available tools for mechanical control in wellbores and their implications for sweep efficiency improvements.

Inflow Control Device placement optimization using reservoir simulation

Mr. Jobin Cherian  
Reservoir Simulation  
Engineer  
SLB

Segmented Injection and Production Profiles Control Technology for Enhanced Recovery in Horizontal Wells

Mr. Wang Yucai  
Chief Engineer  
CNPC R&D

Tuesday, 14 November 2023 | 15:10 - 15:40

Coffee and Tea Break

Tuesday, 14 November 2023 | 15:40 - 17:40

## Session 5: Wellbore Interventions Solutions: Chemical Methods to Control Sweep Efficiency

In this session, we will discuss chemical methods designed for discreet area or single well treatments to alter the rock matrix permeability either near the wellbore or deeper into the reservoir. This will not include field wide or large section use of chemical injection systems like polymer flooding which is handled in session 2. The carefully developed chemical products are used to redirect injected water into the desired portions of the reservoir which have not been effectively swept. In production wells, they are typically used to block permeable layers or areas where water breakthrough has occurred and where the water-cut is extremely high. Some special systems can be used for void space conduit control, but they will be covered in Session 6 which covers VSFs (Void Space Fillers).

Polymer flooding in Carbonate, Learnings from Previous Field Tests

Dr. Hu Guo  
China University  
of Petroleum

AquaCUT TM, a water-based treatment Hydrophilic high salt tolerant polymer (RPM)

Mr. Carlos Sirlupu Ruiz  
Production Advisor  
Baker Hughes

RPM- Relative Permeability Modifier for Carbonate Formations

Mr. Giuseppe Ambrosi  
Technical Manager  
Halliburton

Novel water conformance control system for waterflooding oilfields with low sweep efficiency and lower oil recovery

Dr. Cui Longlian  
Overseas Engineering  
Director  
CNPC - CPET

Tuesday, 14 November 2023 | 18:00

Welcome Dinner, sponsored by Schlumberger



# Technical Program (as of 07 Nov 2023)

Wednesday, 15 November 2023 | 07:00 - 08:00

Arrival of Participants

Wednesday, 15 November 2023 | 08:00 - 08:15

Safety Moment

Wednesday, 15 November 2023 | 08:15 - 09:15

## Session 6: Wellbore Interventions Solutions: Cements and VSF Methods to Control Sweep Efficiency

This session will address the utilization of cements and VSF (Void Space Fillers) tailored to tackle the most severe and often complex and historically difficult permeability control problems in our carbonate fields. We will cover both internal wellbores, near wellbore and deeper reservoir VSC control. Most cements and VSF's will have limited or modest contact with the formation so the influences of carbonate rock on the products functionality will only be discussed in case that the product is highly sensitive.

|  |  |   |
|--|--|---|
| Development and Application of Re-cross linkable Preformed Particle Gels (RPPG) for Conformance Control in the Reservoirs with Fractures or Conducts | Prof. Dr. Baojun Bai<br>Professor<br>Missouri University of Science and Technology | Mr. David Smith<br>President<br>Oilfield Conformance Consulting LLC |
| Potential of Polysaccharides in Enhancing Conformance Control in Oil and Gas Reservoirs  | Dr. Ibnelwaleed Ali Hussein<br>Professor<br>Qatar University                       |   |

Wednesday, 15 November 2023 | 09:15 - 10:15

## Session 7: Well Stimulation while Maintaining Control of Sweep Efficiency

This session is dedicated to enhancing the injectivity and productivity of both injectors and producers while retaining the ability to manage sweep efficiency. The techniques we will explore range from short radius side-tracks, chemical stimulation methods (such as acidization), to various mechanical tools. These tools are used in, but are not limited to, hydraulic jetting, fracturing and multi-stage fracturing.

|   |  |
|---|--|
| Smart Liners Offer Cost-Effective Stimulation of Carbonate Reservoirs   | Dr. Kristian Mogensen<br>ADNOC Senior EOR Specialist<br>Thamama Center |
| Development of Nanoparticle-based Stimulation Fluids and Lessons Learne | Dr. Ben Shiau<br>Associate Professor,<br>University of Oklahoma        |

Wednesday, 15 November 2023 | 10:15 - 10:30

Coffee and Tea Break



# Technical Program (as of 07 Nov 2023)

Wednesday, 15 November 2023 | 10:30 - 12:00

## Session 8: Computational methods including AI and data-driven approaches to improve Sweep Efficiency

Over the history of waterflood operations many computational techniques have been used to enhance sweep efficiency through designing custom pattern reorientations or simply rebalancing fluid throughput. These techniques include Numerical Simulation, Streamline Modeling, Capacity Resistance Modeling (CRM), and now Artificial Intelligence (AI) and Machine Learning. AI is revolutionizing various aspects of modern lives, and the oil & gas industry is no exception. Many industry processes have significantly benefited from AI's optimization capabilities. This session aims to delve into a variety of computational methods, their advantages and limitations while looking specifically at AI as an active tool for sweep efficiency improvement. We'll explore areas where these methods can add values, such as advanced waterflooding modelling and reservoir management tools in carbonate reservoirs, predictive maintenance, and more.

Waterflood optimization for FDP using reservoir simulation

Mr. Coriolan Rat  
Team Lead  
SLB RE

Smart Reservoir Management, Data-Driven  
Production Injection Optimization

Mr. Dorzhi Badmaev  
Sr. Specialist in Cognitive  
Reservoir Management  
ADNOC

Characterization of Complex Carbonate Sweep Efficiency  
using 3D AI-aided NMR-MRI Water Flood Monitoring

Dr. Omar Al-Farisi  
AI Senior Technology  
Advisor to CTO  
Dragon Oil

Wednesday, 15 November 2023 | 12:00 - 13:00

Prayer and Lunch





# Technical Program (as of 07 Nov 2023)

Wednesday, 15 November 2023 | 13:00 - 16:00

## Round Table Session: Key Challenges and Solutions to Solve Sweep Efficiency Problems

In this special session, we selected 5 questions:

Question 1: How does the increasing use of long horizontal wells influence sweep efficiency? Please review the pros and cons of this technology and how we might enhance the advantages and reduce or mitigate the disadvantages. Discuss the enablers: pattern flood design, well placement, lower completion, monitoring limitations and impacts on ability to implement physical intervention solutions.

Question 2: What do you feel are the most important needs to further improve our ability to solve or manage Sweep Efficiency or Conformance issues? (Examples: Better training, improved diagnostic tools, monitoring automation and digitalization, enhanced or different products for controlling permeability, enhanced or different products for controlling VSC problems, etc.)

Question 3: When it comes to the benefit analysis for sweep efficiency or conformance control initiatives, what should we consider in quantifying this value? (1) Business case for intervention, expected added value (2) quantification of realized value, instantaneous vs long term (3) Better quantification of the indirect cost savings, e.g., facility capacity for water management, and associated CAPEX/OPEX, contribution to emissions reduction...

Question 4: How does an integrated strategy for sweep efficiency and conformance control play a key role in the journey to carbon neutrality in maturing assets, and contribute to Oil & Gas industry sustainability ambitions? (Water related Carbon intensity)

Question 5: When leveraging computational methods to optimize waterflood / sweep efficiency (Data driven or AI approaches, reservoir simulation and streamlines, or hybrid models): how critical is the frequency, quality, and accuracy of the data input? (Discuss the value, justification, realities, and limitation of this data and its impacts / or restricted application)

A question at each table, 60-minute discussion with each table getting 15 minutes for a report back to the general audience

Wednesday, 15 November 2023 | 16:00 - 17:00

Summary and Closing Remarks



14-15 November 2023

# CNPC R&D SYMPOSIUM:

## WATERFLOODING SWEEP EFFICIENCY ENHANCEMENT

### SEE YOU AT THE EVENT!

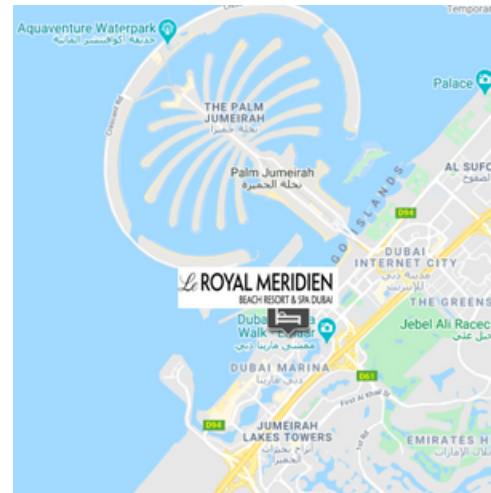
Please click the link to see the location.

#### Le Royal Méridien Beach Resort & Spa

Al Mamsha St., Dubai Marina

<https://maps.app.goo.gl/A2qXK8GnsZvPL29z5>

Please follow the signages from the entrance or parking lot to direct you to the venue.



In case you will require further assistance, please contact John at +971 52 531 7308 or Umid +971 56 603 8450

#### OUR PARTNER HOTEL FOR ACCOMMODATION

Millennium Place Barsha Heights Hotel

**HANNA FAYE RAMINTAS**

+971 58 606 0840

[h1014.sales11@millenniumhotels.com](mailto:h1014.sales11@millenniumhotels.com)

**CNPC R&D will cover the registration fees.**

**The company of the participant shall bear their travel expenses.**

Please email the hotel with subject **"CNPC Symposium"** to avail the corporate rate.