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Cairn Oil & Gas

EOR application in Rajasthan Fields




Agenda

- Rajasthan Fields Overview
- MBA Fields Introduction
- Mangala EOR Story
- EOR Key Enablers
- EOR Way Forward
- Enabling Framework for EOR Policy
- Summary

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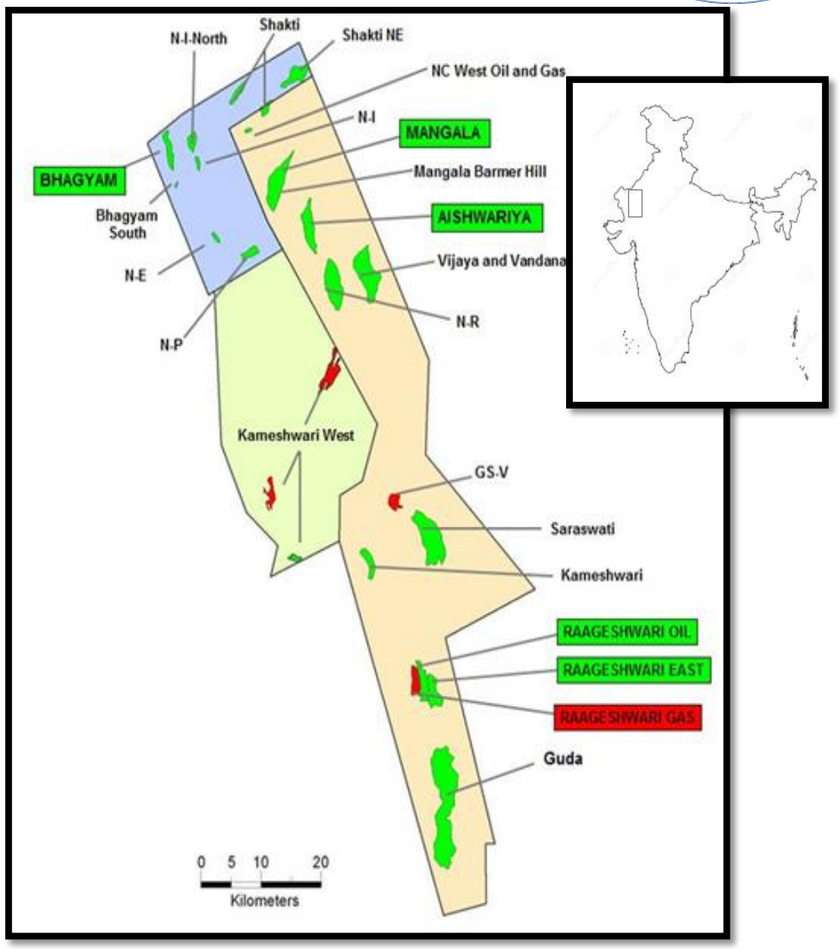
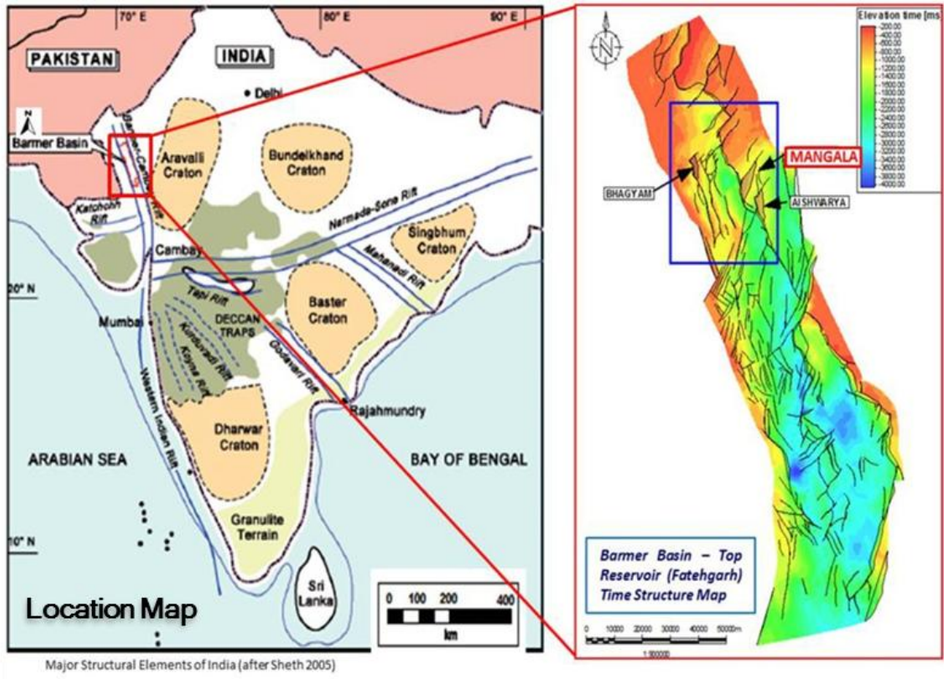
Rajasthan Fields Overview

- Location: Barmer basin, Rajasthan
- Block- RJ-ON-90/1
- Discovered in January 2004
- Production started in August 2009 in Mangala; 2012- Bhagyam, 2013-Aishwariya
- Main producing reservoirs- Fluvial sands of Fatehgarh Formation





Mangala, Bhagyam and Aishwariya together hold~2.1 Billion Barrels of Oil

MBA Produces~20% of India's Total Oil Production

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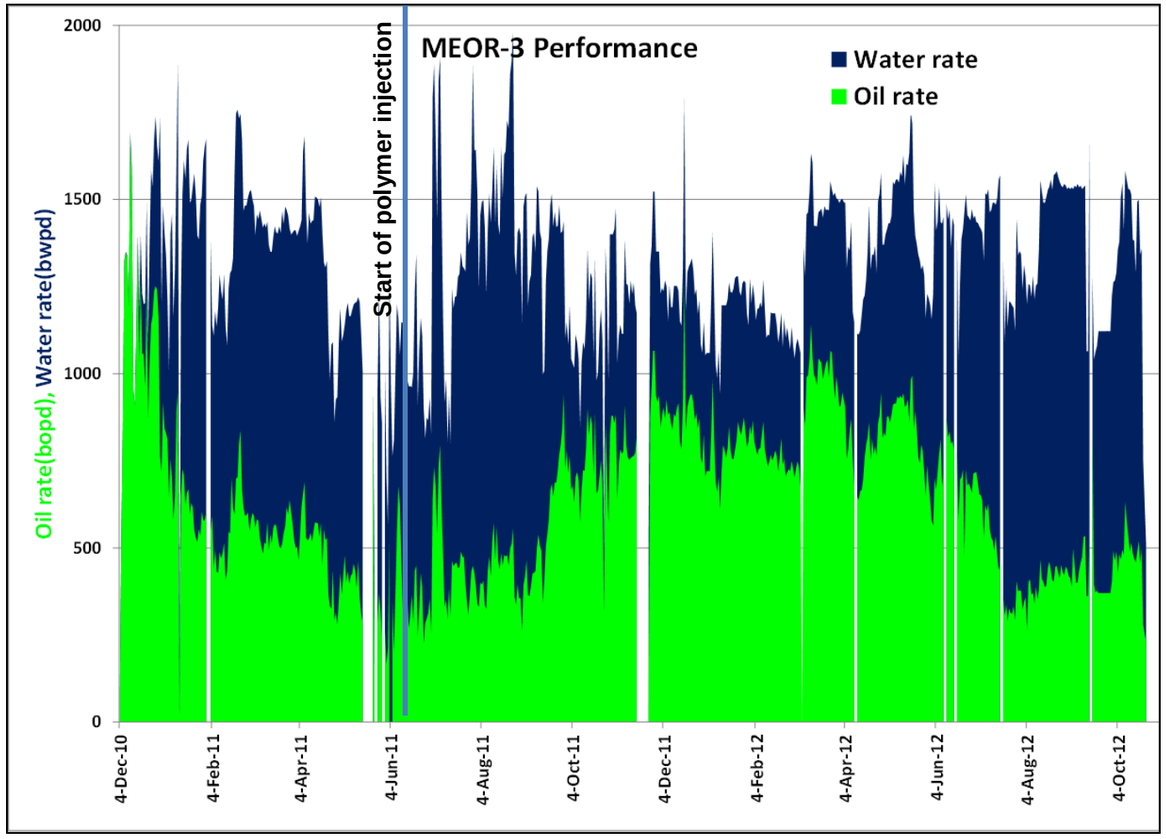
Mangala Field Update

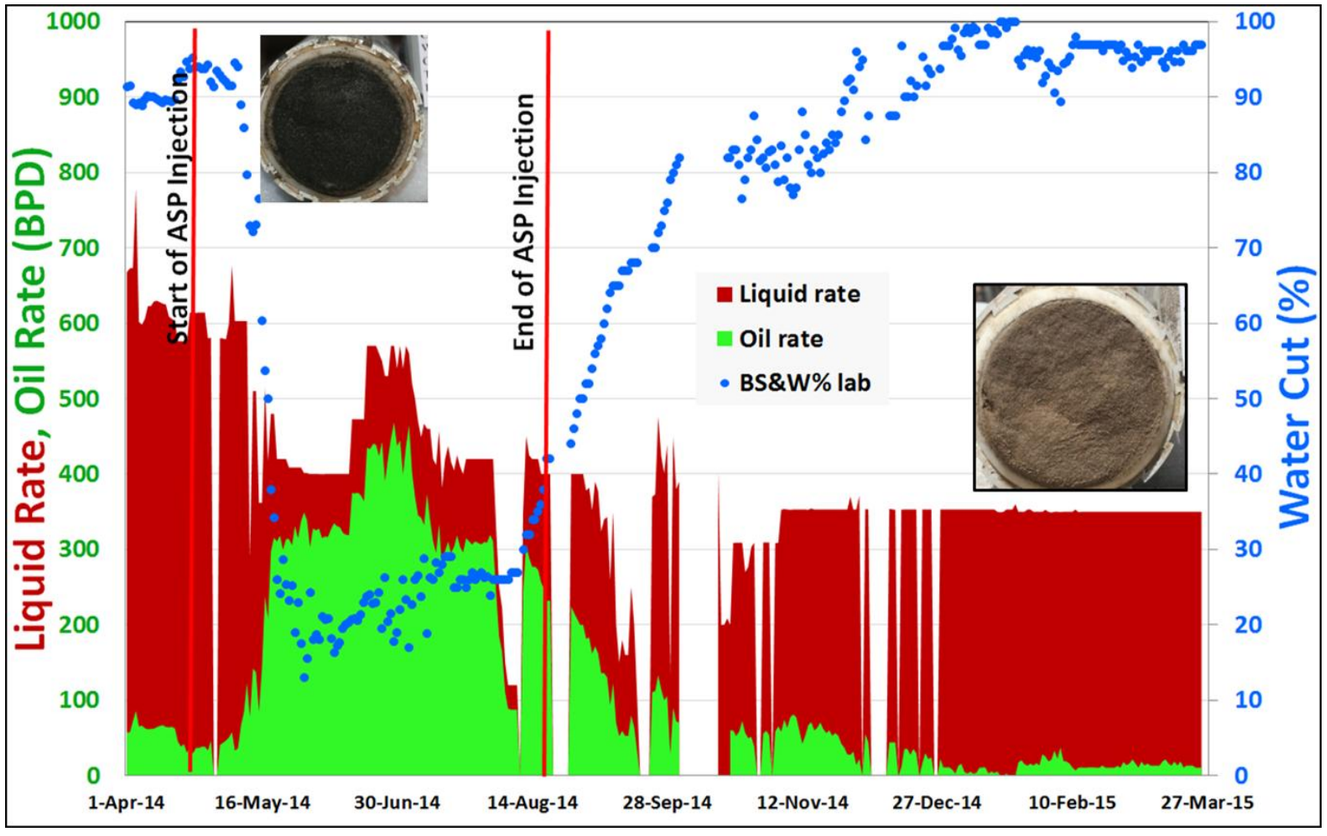
- Mangala is a thick, multi-darcy reservoir containing relatively viscous (~15cp) and paraffinic crude oil, discovered in 2004.
- Independent EOR screening studies began in the year of discovery, and confirmed chemical EOR as the best choice for Mangala.
- Laboratory work began in 2005, immediately after screening studies.
- Reservoir simulations helped justify and design a pilot for field testing of chemical EOR processes.
- Polymer pilot conducted in 2010-12, soon after production start in 2009.
- Field scale polymer injection started in Nov 2014 through skid.
- Full field injection in 2015 through Central polymer facility (CPF), largest centralized polymer facility in the world.
- ASP Pilot conducted in 2014-15 simultaneously with full field polymer flood implementation.
- Work ongoing for larger scale ASP expansion.

Mangala Crude at Room Temperature

Mangala – Two Successful EOR Pilots

Objectives : Estimate EOR incremental recovery in actual field conditions





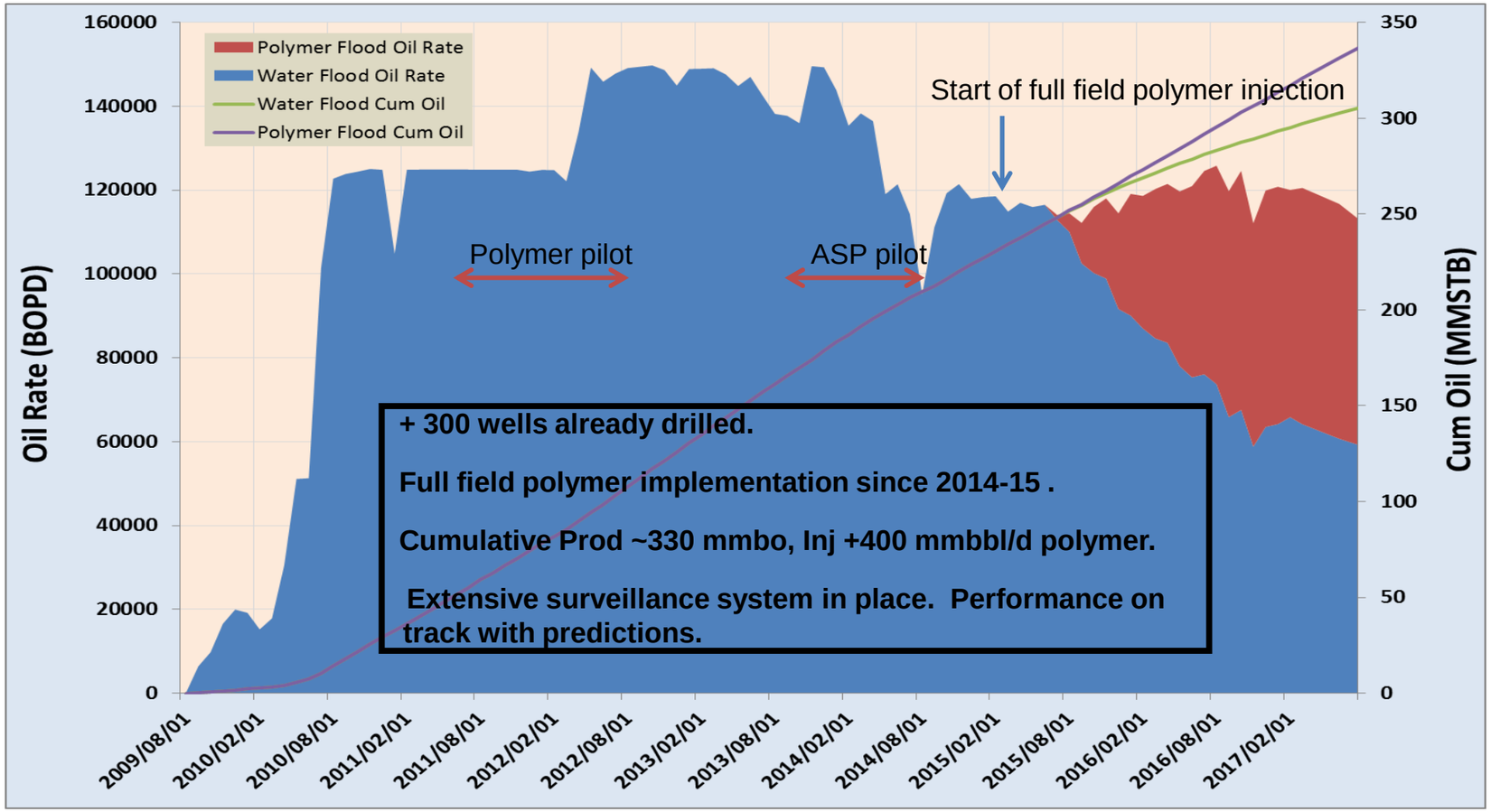
Polymer Flood Pilot

Positive polymer flood response observed;
Incremental Recovery over WF ~11% of Pilot STOIIP

ASP Pilot

Eight Folds increase in Oil Rate in ASP Pilot;
Incremental recovery over PF >20% of Pilot STOIIP;
One of the best published ASP Pilot performance results in the world

Mangala - Performance Update



- Polymer Flood contributing~55,000 BOPD;
- Polymer EOR production is nearly 35% of total Rajasthan production and nearly 8% of total country's domestic production
- Expected Incremental Production of~100 MMbbls (2030)

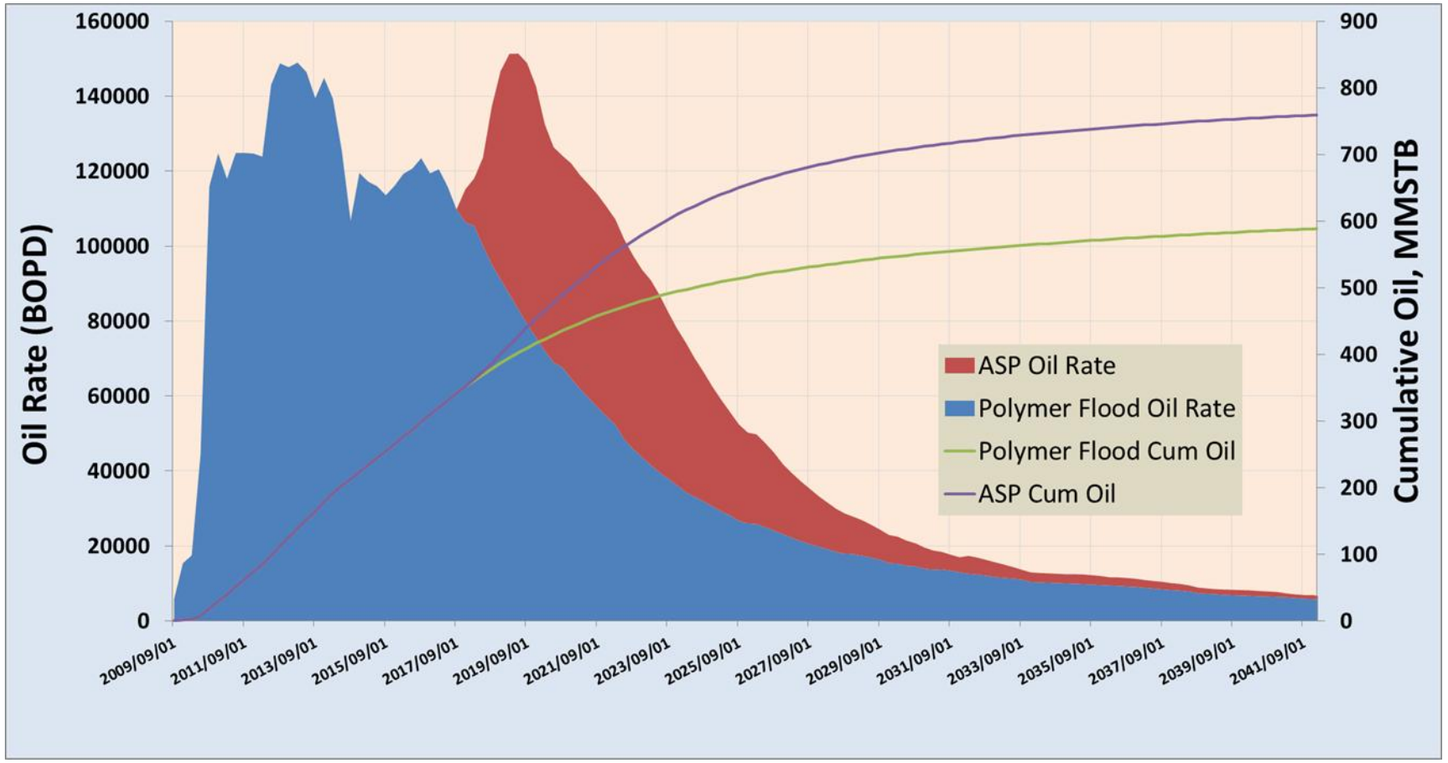
EOR Key Enablers

- Outside Technical Advisors
  - Technical screening work began the year Mangala was discovered, and was followed immediately by detailed lab work & simulation modeling.
  - Cairn technical staff examined several pilot alternatives, even the possibility of starting an EOR pilot before production startup.
  - Outside technical advisers were invaluable in providing guidance, ideas, and support where appropriate and challenge where necessary.
- Management Support
  - The prevailing technical attitude has been to “Plan for Success” but to be prepared for the unexpected; in essence, to go forward aggressively while maintaining as much flexibility as possible.
  - Cairn management was very supportive of these efforts.
  - Both the JV Partner (ONGC) and regulatory agency (DGH) were supportive of these efforts.
  - The importance of consistent management support & encouragement on such a high-profile technical project is critical.
  - This technical and commercial foresight combined with aggressive planning has positioned the JV to implement chemical EOR in virtually a secondary mode at Mangala.

EOR Way Forward

- Bhagyam Polymer Flood
  - Polymer injectivity test accomplished
- Aishwariya Polymer Flood
  - Polymer injectivity test accomplished
- Bhagyam & Aishwariya ASP Pilots
  - Lab studies in progress
  - Pilot design ready
- Mangala Full field ASP
  - Facilities concept study ongoing
  - Staged expansion planned
  - High End Pioneering project
  - **High Capex & Opex, lower oil price challenge**

Mangala Full Field ASP implementation



- ASP Flood Potential ~150 MMBBLS by 2030 in Mangala alone
- EUR expected to exceed 50% of STOIIP
- Together in MBA, ASP potential in excess of 200 mmbbls
- Successful ASP implementation expected to add 50,000 to 100,000 bopd helping to meet oil import reduction target

Enabling Framework for EOR Policy

- Operators while planning for field development, should evaluate possibility of application of EOR. This is because planning EOR early in the life of a field provides for maximum recovery.
- Abolish Cess for production from EOR / IOR.
- Attract reduced rate of royalty on production from EOR / IOR.
- The cost of chemicals for EOR project should be allowed to capitalize.
- Invite, facilitate and suitably incentivize companies willing to invest in polymer plant to service Indian market. This would be largely through ease of doing business and relaxed labour laws.

GOI recognizes EOR role: Supportive policy: Next step forward

- One of the thrust areas identified in India's Five Year Plans for overall development of E&P industry has been optimizing recovery from ageing oil & gas fields

- *Report of the Committee on roadmap to reduce import dependency in energy by 10% by 2021-22* clearly highlighted the need for incentivizing EOR projects

- GOI's numerous notifications specify reduced rate of royalty for production from fields under EOR/IOR

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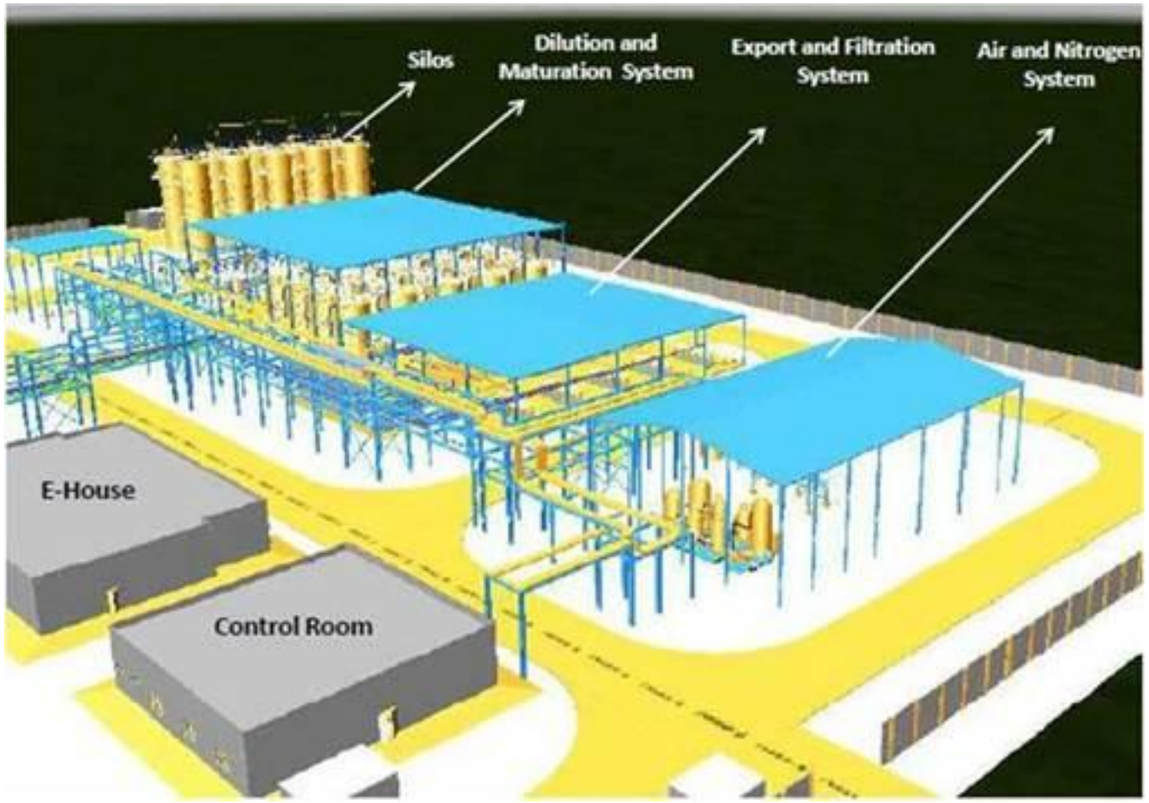
Summary

- Chemical EOR has potential to increase oil recover factor by 15-20% over water flood
- Limited number of ASP projects across globe
- Involves high end pioneering technical work for field development planning
- Surface facilities design and Chemical supply chain logistics critical
- Technical innovations and government incentives required for making the project attractive at lower oil prices
- Policy support to help Cairn work towards early ASP Flood expansion in the Mangala Field followed by Bhagyam and Aishwariya Fields

ASP has Potential to add More than 200 MMBBLS in key MBA Fields in Rajasthan;
Could be pacesetter for similar fields in India and across globe

Thank You

EOR Pilot Facility



Central Polymer Facility Schematic
(World's largest centralised facility)