

Challenges for Gas Flooding

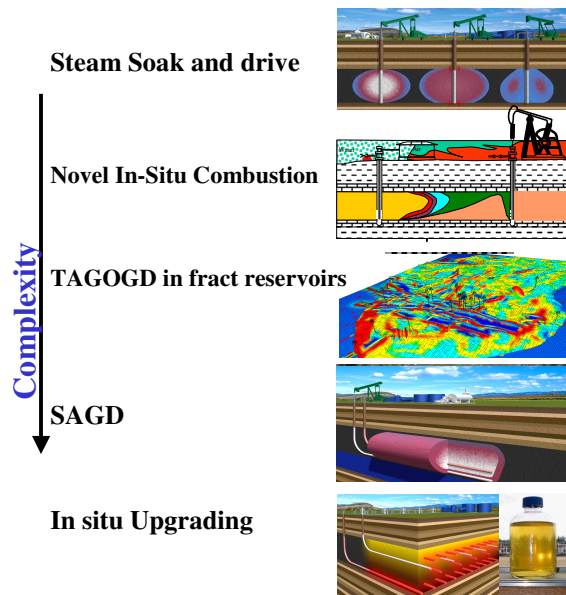
- Sweep
- Source of trapped gas, acid gas or captured CO₂
- Multi-field solutions
- Cost and materials

R&D

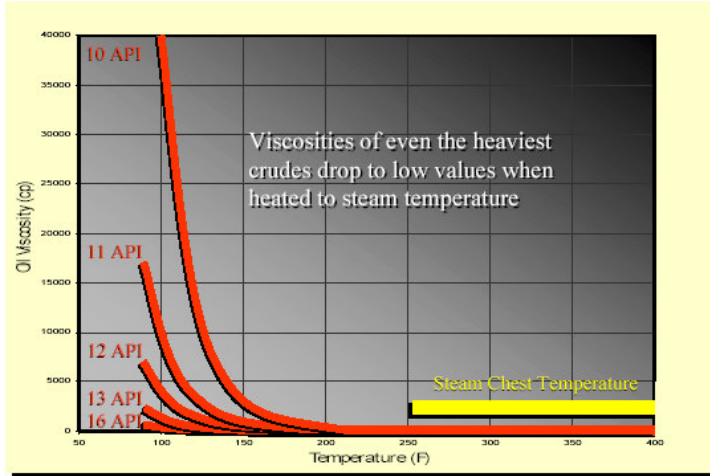
- Increase sweep
- How to use Foam to enhance sweep over large distances and in the presence of oil
- Integrate aspects of CO₂ sequestration in CO₂ EOR
- Acid gas reactive processes
- Material and cost aspects of CO₂ capture



Heavy Oil



Viscosity reduction with temperature



History pre-2000

Brief History of Thermal Recovery

- 1930s - early field test of soak and drive (Woodson, TX)
 - in-situ combustion projects in U.S.S.R
- 1950s - in-situ combustion, hot water, and steamdrive pilots in U.S., Canada, and Venezuela
 - steam soak rediscovered (Mene Grande, 1959)
- 1960s - soaks come into common use
 - first commercial steamdrives
- 1970s - steamdrive replaces soak as dominant thermal recovery method in U.S.
- 1980s - experimentation with foams and horizontal wells
 - U.S. thermal production approaches 500,000 B/D
- 1990s - horizontal wells come into common use
 - formation of Aera (Shell/Mobil), dominant CA producer and user of thermal recovery technology



Kern River California (1986)



Schoonebeek Steamflood (1960)



Lake Maracaibo Steam Soak (1965)



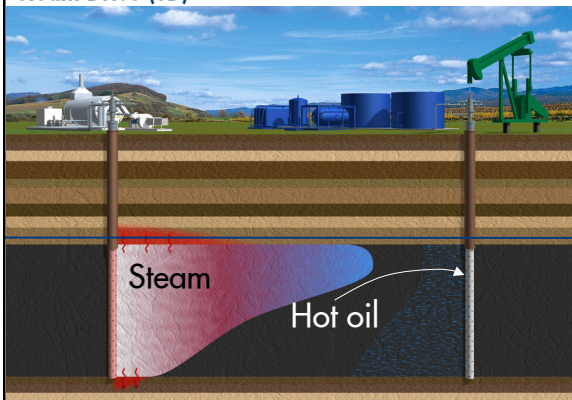
Current Thermal EOR Activities

- **California**
 - S. Belridge Tulare, Midway Sunset, etc. – steamfloods optimization
 - S. Belridge Diatomite – demonstration of steam injection into tight, light oil reservoir
- **Netherlands**
 - Schoonebeek – horizontal well steamflood re-development in execution
- **Oman**
 - CSS/steam drive pilots, projects design under way
 - Qarn Alam, Fahud – steam assisted GOGD in fractured carbonate reservoir in execution
 - Mukhaizna – steam drive development progressed by Oxy
- **Canada**
 - Peace River cyclic steam stimulation project
 - Orion SAGD project



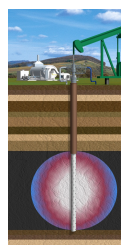
Heating the oil with steam

Steam Drive (SD)

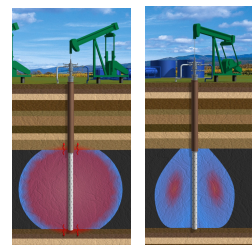


Cyclic Steam Simulation (CSS)

Inject

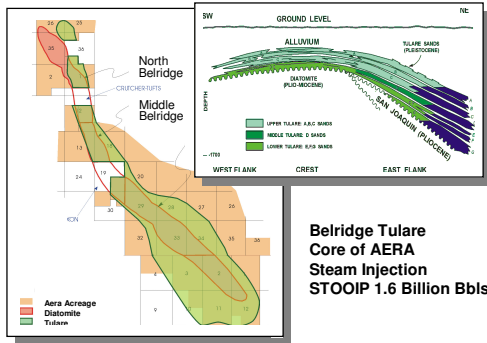


Produce

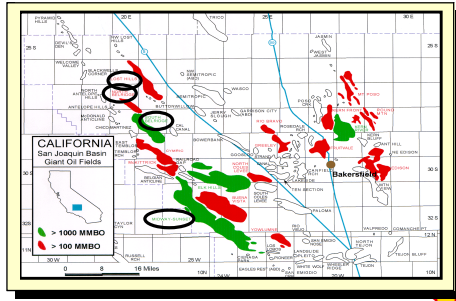


Steam Injection – Belridge Example

Operated by Aera, a Shell JV
 Produces 235,000 b/d from 15,000 wells,
 Headquarters in Bakersfield, California
 (1150 employees)
 Demonstrated operational excellence

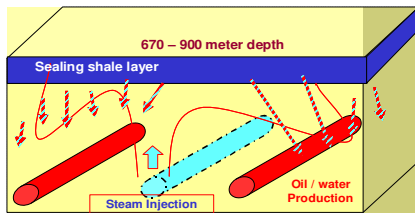
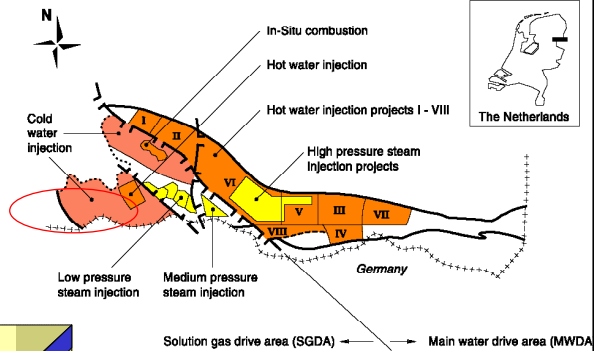


Belridge Tulare
 Core of AERA
 Steam Injection
 STOPIP 1.6 Billion Bbls

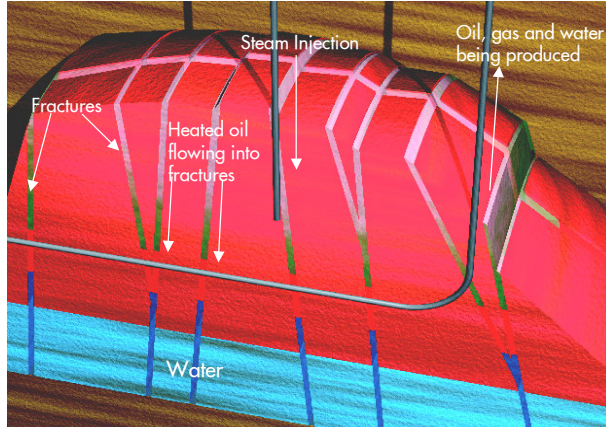
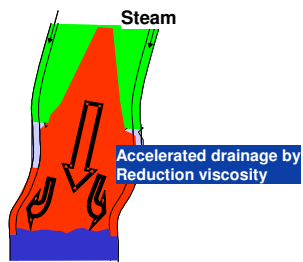


The Schoonebeek Steam Project

- 16 km x 5 km, around 20 m thickness, depth 800 m
- Bentheim Sandstone
- Porosity 30%, 0.5-4 Darcy, STOIP 1 bln bbls
- Oil Viscosity 160 cP @ 40°C, 25 API, 19% wax
- Initial Development in SGDA



Qarn Alam field - Oman Fractured Carbonates & Thermal Assisted GOGD



Thermal Assisted Gas Oil Gravity Drainage process at Qarn Alam
Contracts awarded



Extra Heavy Oil: Wash your hands afterwards...

Canada Oil Sands

