RECOVERY OF MORE OIL-IN-PLACE AT LOWER PRODUCTION COSTS WHILE CREATING A BENEFICIAL WATER RESOURCE

DE-FC26-02NT15463

Aera Energy LLC

Bob Liske
(661)-665-5446
10000 Ming Ave.
Bakersfield, CA 93311

raliske@aeraenergy.com

Project Partner

Kennedy/Jenks Consultants

Larry Leong
(949)-261-1577
2151 Michelson Drive, Suite 100
Irvine, CA 92612-1311

LarryLeong@KennedyJenks.com

Aera Energy LLC

- One of California's largest oil/gas producers

  (~210,000 BDP Oil, ~70 MMSCFD Gas, Reserves > 900MMBBL)

- Formed June 1997, jointly owned by affiliates of Shell and ExxonMobil

- Approximately 1100 employees (Aera Energy Services Company)

Project Goal

Development of a reliable, economic means of removing excess produced water from the San Ardo oilfield by converting it into a potential new water resource

Project Location

San Ardo Oilfield

- Field discovered in 1947
- Heavy oil (12° API)
- Steam used to reduce oil viscosity and increase recovery
- Aera - one of two major operators - produces 70% of daily production in the San Ardo field
- Current Aera oil production ~7,000 bpd

Aera San Ardo Produced Water

- Producing wells ~95% water cut
- 140,000 BPD total water production

  40,000 BPD softened for steam

  100,000 BPD produced water re-injected

Aera San Ardo Oilfield

- Limited injection zones exist within oilfield for water re-injection
- High reservoir pressures from re-injection degrade steam performance. Water cuts have increased over time to ~95%
- Ability to dewater reservoir may be key to future development of field

Project Scope / Approach

- Phase I
  - Investigate potential treated water use
  - Regulatory review
  - Treatment technology evaluation/ selection
- Phase II
  - Pilot construction/operation
  - Tech transfer

Current Status / Schedule

- Phase I completed
- Phase II
  - Pilot operation / data collection completed
  - Technology transfer activities and Final Report preparation underway
  - Final Report due July 2006

Project Summary

- Identified & evaluated potential end-use options for treated water
  - Nearby agriculture
  - Use by MCWRA for Seawater Intrusion Project
  - Industrial or power plant use in King City
- Established water quality treatment goals for demonstration facility

Project Summary (cont.)

- Summarized regulatory issues and requirements pertaining to treatment, storage, delivery, and use of treated water
- Completed technical/economic evaluation of alternative water treatment technologies
- Completed design & construction of small-scale water treatment demonstration facility

Project Summary (cont.)

- Established optimum chemical dosages and pH range for treatment process
- Determined boron removal for two different RO membrane types
- Determined ammonia removal efficiency
- Developed planning level estimates of capital and operating costs for full-scale system

Project Benefits

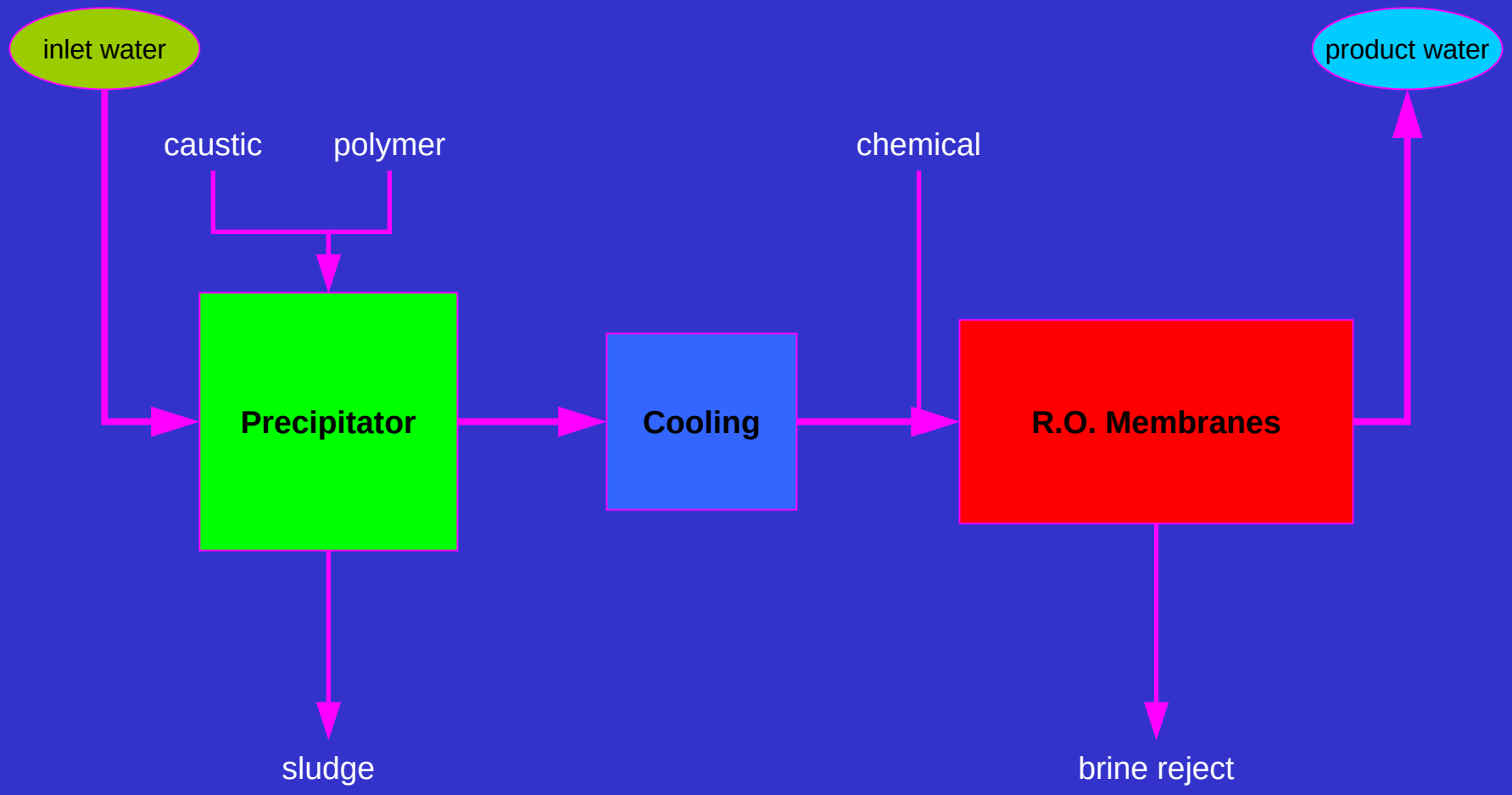
- San Ardo
  - Potential “win-win” situation whereby oil production rate and recoverable reserves are enhanced by dewatering the oil reservoir while at the same time creating a new, reclaimed water resource

Water Quality

Parameter	Produced Water	Treated Water Goal
TDS (mg/l)	7000	<400
Temp. (F)	190	< 90
Boron (mg/l)	25	< 1
Ammonia (mg/l)	30	< 5
TOC (mg/l)	75	< 1
Hardness* (mg/l)	325	< 10
Silica* (mg/l)	225	< 60

* treatment based goal for RO membranes

San Ardo DOE Project Treatment Process



AMERICAN COOLING TOWER, INC.
RENTAL DIVISION
800-371-5959
Clarifier
Cooling Tower
RO

Breathing
Apparatus

3
2
0

EMPTY

Key Findings

- Precipitation softening followed by RO membranes can achieve overall TDS objective (<400 mg/l) with a water recovery rate of ~75% for this particular location.
- Silica removal to target levels (<60 mg/l) accomplished with magnesium chloride addition.
- Boron removal to ~1 mg/l by RO with proper pH control; however, additional treatment steps required to achieve lower levels.

Key Findings (cont.)

- Despite success of demonstration facility, significant obstacles and uncertainties remain for a full-scale project. Examples include seasonal demand for the water, high conveyance costs, uncertain user acceptance, regulatory and permitting issues, and the long-term reliability of the process.

Technology Transfer

- Local SPE and water industry presentations:
  - SPE Section mtgs. Bakersfield, Santa Maria, Denver
  - West Coast PTTC
  - Channel Counties Water Agency
- Water Reuse Symposium – Sep. 05
- International Petroleum Environmental Conference – Nov. 05
- Anticipate four other national SPE / water industry papers & presentations

Project Funding

- Anticipated DOE contribution (80%)

  $1,087,369

- Aera + Kennedy/Jenks contribution (20%)

  $277,219