

Feasibility of Treating Oilfield Produced Water to Create a “New” Water Resource

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Overview

- How did K/J get involved in produced water reuse?
- Why is there interest in California?
- What has been done ? (Arco Placerita Canyon pilot study)
- Where do we go from here? (Aera Energy San Ardo demonstration project)

How Did K/J Get Involved?

- Long-term relationships with many public water utilities in California
- Water reclamation expertise
- Understanding of oilfield produced water management issues
- Advanced Technology Group

Why Is There Interest?

- Many oil fields in Southern and Central California underlie areas with water recycling interest.
- Produced water from lower salinity fields may be amenable to treatments that are competitive with other new water sources.
- Significant volumes of produced water may be available in California for non-potable beneficial reuse.

Oil Company Economic Drivers

- Potential to improve crude oil recovery in TEOR operations
- Lack of disposal capacity using current practices
- Avoided costs

Cost/benefit analysis required:

- Evaluate anticipated production increases and/or avoided costs vs. cost of water treatment.

Potential Water Utility Motivators

- Water utilities seeking new sources of water due to decreased reliability of existing water supplies.
- Diversion of water for environmental use.
- New drinking water regulations are increasing water costs
- California policy that use of drinking water for non-potable uses is waste of valuable resource.
- Recent improvements in life of membranes lower treatment cost.

Ideal Scenario

- Water purveyor looking for new sources of reclaimed water that can meet needs of users.
- Oil producer needs to do something with produced water other than re-injection.
- Proximity to nearby water user who need reclaimed water.
- Existing regional water conveyor infrastructure or government funding to build infrastructure to deliver reclaimed wastewater to users.

Placerita Canyon Pilot Test

- TEOR oilfield in Northern Los Angeles County.
- ARCO interested in alternative to Class II disposal.
- Castaic Lake WD interested in new sources of reclaimed water to support urban growth.
- Castaic Lake WD considering funding of parallel non-potable water distribution system.
- DOE provided funding for 100 gpm, 12 month produced water treatment demonstration project.
- Industrial, irrigation and potable reuse options evaluated.

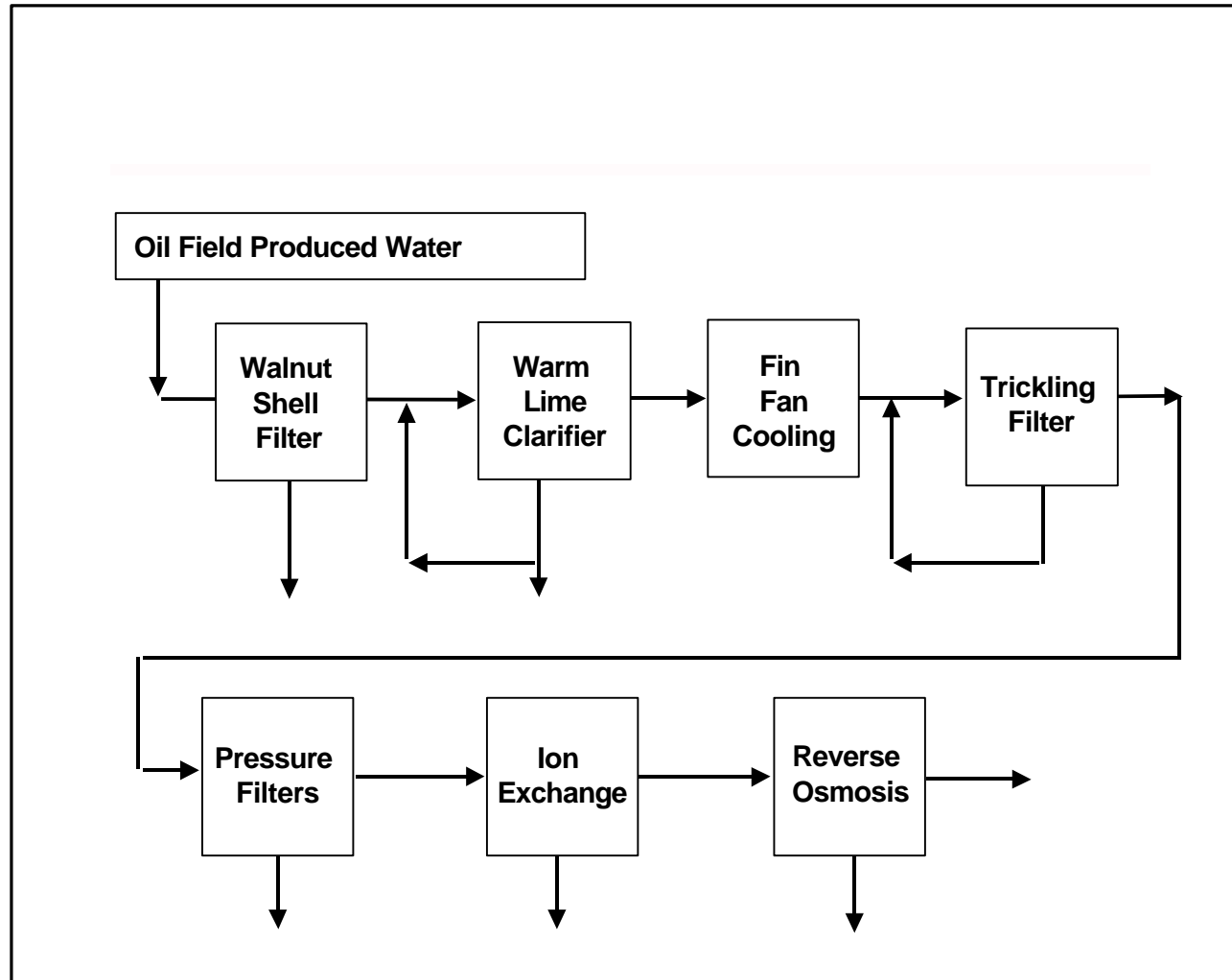
Major Water Quality Issues

- Total dissolved solids
- Temperature
- Organics
- Silica
- Hardness
- Ammonia
- Boron

Water Treatment Goals

	<u>Ambient</u>	<u>Goal</u>
Total Dissolved Solids (mg/l)	6,000	500
Total Hardness (mg/l as CaCO ₃)	1,500	600
Total Organic Carbon (mg/l)	120	1-2
Ammonia (mg/l-N)	15	1
Silica (mg/l)	200	200, 60, 30
Temperature (° F)	190	100
Boron (mg/l)	20	1
Chloride (mg/l)	2,400	500

Pilot Plant Schematic



Pilot Study Results

- Total Dissolved Solids- RO achieved more than 95% removal over broad pH range.
- Hardness- Warm water softening achieved more than 90% removal at pH of 9 or above.
- Silica- Warm softening achieved 90% removal at pH of 9.8; 98% removal with addition of 400 mg/l of magnesium chloride.
- Boron- 20% removal by warm water softening, increasing to 55% by addition of magnesium chloride; RO removed 90% at pH of 10.8.

Pilot Study Results (cont)

- Ammonia- RO achieved 80% removal at pH of 8.7 or below.
- TOC- RO achieved 90% removal over broad pH range.
- RO concentrate- 25% of treated flow with average TDS pf 24,447 mg/l.

Treatment Cost

- Estimated treatment cost for full scale (44,000 bpd) plant varied from \$0.09/bbl (industrial use) to \$0.41/bbl drinking water use.
- Offset by benefits of increased oil production and lower operating costs.
- Treatment cost affected by:
 - ✓ Caustic price
 - ✓ Electricity
 - ✓ Membrane Replacement
 - ✓ RO reject and sludge management

Where do we go from here?

Aera Energy San Ardo Oilfield

- DOE grant awarded for demonstration project in fall 2002.
- TEOR operation in Monterey County.
- Follow-up to water marketing study.
- Objective to show that produced water can be reliably treated for agricultural reuse.
- Trials will include use of recycled caustic, evaluation of Class II disposal of RO reject and use of longer life membranes.

Water Marketing Issues

- Water Quality
- Seasonal Storage
- Duration of Supply
- Conveyance Facilities
- Water blending opportunities
- Institutional, legal, regulatory issues
- End user and public acceptance

Concluding Remarks

Feasibility of beneficial reuse of oilfield produced water is site-specific and highly dependent on:

- oilfield economics (very important)
- chemical composition of the produced water
- reducing treatment costs
- specific needs of a water district
- location of water conveyance infrastructure
- government funding of water distribution systems
- user and public acceptance of this alternative water source