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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ambient</th>
<th>Goal</th>
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<tbody>
<tr>
<td>Total Dissolved Solids (mg/l)</td>
<td>6,000</td>
<td>500</td>
</tr>
<tr>
<td>Total Hardness (mg/l as CaCO3)</td>
<td>1,500</td>
<td>600</td>
</tr>
<tr>
<td>Total Organic Carbon (mg/l)</td>
<td>120</td>
<td>1-2</td>
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<tr>
<td>Ammonia (mg/l-N)</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>Silica (mg/l)</td>
<td>200, 200, 60, 30</td>
<td>200, 60, 30</td>
</tr>
<tr>
<td>Temperature (°F)</td>
<td>190</td>
<td>100</td>
</tr>
<tr>
<td>Boron (mg/l)</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Chloride (mg/l)</td>
<td>2,400</td>
<td>500</td>
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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