Optimization of Water Usage At Petroleum Refineries

Water/Energy Sustainability Forum
Ground Water Protection Council
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Agenda

• Overview water usage in petroleum refineries.
• Discuss drivers for water conservation.
• Review opportunities to reduce water consumption:
  – Matching supply quality to the demand need.
  – Utilization of municipal wastewater.
  – Zero discharge concepts.
Water Use in Petroleum Refineries

• Adding heat to the processes (steam).
• Removing heat from the process (cooling water).
• Removing salt and impurities from crude.
• Protecting equipment from corrosion.
• Generation of hydrogen (used to remove sulfur from motor fuels).
• Equipment cleaning and maintenance.
Water Usage in the Petroleum Refining Industry

Water usage varies greatly from facility to facility.
Gallons/bbl Doesn’t Tell the Story…

• Raw water quality varies:
  – Target ion concentrations.
  – Hardness.

• Refinery configuration
  – Water usage very linked to energy efficiency of the facility.

• Crude slate
  – Poor quality “price advantaged” crude oil requires more water.

Some refineries have much greater challenges than others in their efforts to control water usage.
Primary Uses

- Cooling Water: 53%
- Steam: 42%
- Potable Water: <1%
- Utility Water: 5%
The Water Used Is:

- Contained in sludges: 5%
- Consumed: 5%
- Vented as steam: 11%
- Evaporated: 38%
- Discharged: 41%

Evaporated equates to energy lost.
Cost Drivers

[$/1000$ Gal.]

- S.W. LA Industrial Water
- Typical Industrial Well Water
- Midwest Public Water
- EBMUD
- Los Angeles Area (current)
- Los Angeles Area (projected)
Other Drivers

• Some refineries have had to cut rates due to limited water supply.
  – Direct costs of water may be low.
  – Cost of lost production is very high.
Water Conservation Opportunities

• Matching Water Quality with Process Requirements.
• Treated Municipal Wastewater Reuse Projects.
• “Zero Discharge” Concepts.
Match Water Quality with Process Requirements

- Many facilities utilize water from more than one source.
- All facilities generate reusable wastewater streams.
- Better quality water sources should be supplied to processes that can benefit from them.
Cooling Tower Example
Cooling Towers

Evaporation

Raw Water

ΔT

Process Heat Exchangers

Blowdown to Remove Calcium, Magnesium, Silica, etc.
Considerations

• Cooling towers must be “blown down” to prevent problem ions from concentrating to the point that they form scale when heated in process exchangers.
• Depending on water quality, cooling tower blowdown ranges from 10 to 30% of the raw water make up rate.
• Water sources with lower problem ion concentrations result in reduced blowdown rates, resulting in water savings.
• Water with higher problem ion concentrations can still be used in processes where the water will not be heated.
Alternate Sources of Cooling Tower Make-up

• Reverse osmosis unit reject (from boiler water treatment).
• Cold steam condensate.
• Excess boiler feedwater.
• Alternate water supplies.
Cooling Tower Example

By switching to a readily available water source with lower silica concentrations (5 ppm vs. 50 ppm), water demand was reduced by over 600 gpm.
Reuse of Treated Municipal Effluent

• In some areas, municipal effluent is being provided to industry as a substitute for fresh water.

• California’s East Bay Municipal Utility District has successfully implemented one project, and is planning others.

• Los Angeles and Anglian Water (U.K.) are also planning projects.
Typical Reuse Process

Public System

Publically Owned Wastewater Treatment System

Industry

Zeolite Softening

Reverse Osmosis System

Reject to Disposal or Discharge

High Quality Water Supply
Benefits

• Proven technologies.
• Recovers up to 70% of municipal wastewater.
• Provides a very high quality water supply—supports low usage.
Concerns

• So far, economically feasible only with subsidies (California and the U.K.).
• Produces waste stream with high dissolved solids—disposal issues.
Zero Discharge Concepts

- The “zero discharge” concept has been around for many years.
- Serious planning to achieve zero discharge is just now starting to take place.
- Existing infrastructure, coupled with new technologies can bring facilities close to the zero discharge goal.
Zero Discharge Challenges

- Salts and impurities must be removed from the system.
- Make up is still required to replace large evaporation rates.
Zero Discharge Process
Summary

• Petroleum refining is a water intensive industry.

• Increasing water costs, availability, and conservation initiatives are driving the need to re-evaluate usage and supply alternatives.

• Improved water use strategies, old technologies, and newer technologies are providing opportunities.