UNIVERSITY OF IDAHO COOLING TOWER CASE STUDY

(ENHANCING WATER SUSTAINABILITY)

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OUTLINE:

- Water scarcity
- Case study: University of Idaho (UI)
- Facts, Objectives, Technical Solutions
- Case Study (Three Options)
- Analysis (Three Options)
- Pros and Cons (Three Options)
- Performance Comparison
- Conclusion
- Future Work

WATER SCARCITY

- Available freshwater is 2.5%
- ~2 billion people have little clean water access (WHO)
- 88 developing countries (half the world's population) do not have clean water
  - 80-90% of diseases and 30% of associated deaths
- Water usage doubles every 20 years

CASE STUDY: UNIVERSITY OF IDAHO

UI, Moscow campus district heating and cooling plant:

- heating and cooling for up to 65 buildings
- Fuel:
  - Biomass, 95% wood chips
  - Natural gas, 5%

Figure 1: This is the UI district heating and cooling plant

FACTS:

- UI district cooling loses 2,000,000 gal through cooling towers
- Currently, 100% of cooling tower water is lost
- The Palouse Region aquifer is depleting faster than it is replenishing

Figure 2: The cooling towers (on the roof) for the district heating and cooling plant

OBJECTIVES

- To capture the vapor to reuse in the cooling cycles

  - Condition:

  - Make-up water needs to be filtered before it can reenter the system
    - Preclude pump fowling
    - Reduce pump and pipe corrosion

TECHNICAL SOLUTIONS:

- **Option 1:** Modifying the current hot lime softening (HLS) system by adding a Reverse Osmosis (RO) system (which is available in the plant)
- **Option 2:** Membrane filtration, utilizing a staged filter arrangement
- **Option 3:** Proprietary method

OPTION 1

Integrated HLS with RO system

1. Add the available RO system to current HLS
2. Using RO needs a heat exchanger to reduce the water temperature from 82°C to 65°C

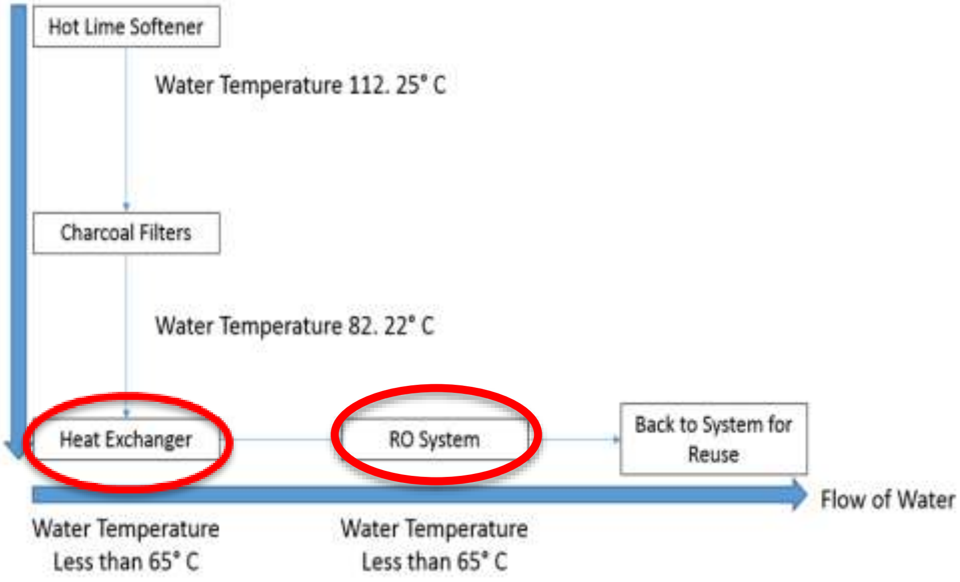

Figure 3: Flow of water for option 1

OPTION 2

Utilizing membrane filtration

1. Replacing HLS and charcoal with membrane filtration
    a. utilize Ultrafiltration (UF) membranes (Pore size 20,000 DA down to 1,000 DA)
    b. utilize Nanofiltration (NF) membranes (Pore size 300 DA down to 150 DA)
2. Using available RO system

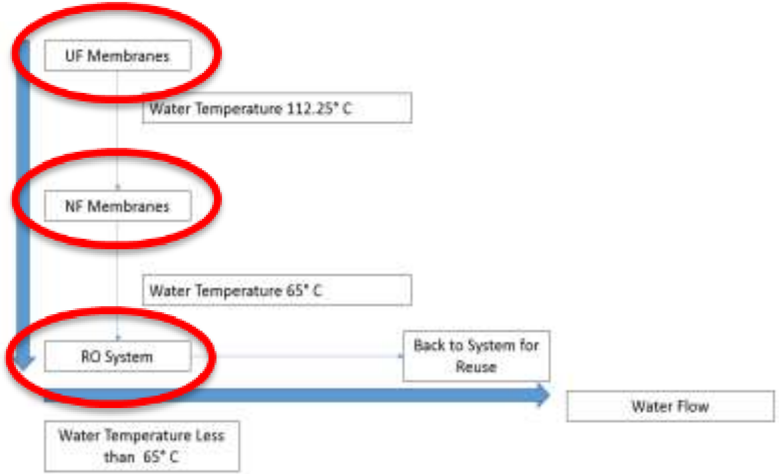

Figure 4: Flow of water for option 2

OPTION 3

Proprietary method based upon spherical adsorbent materials and forms

1. Replacing the HLS with Proprietary system

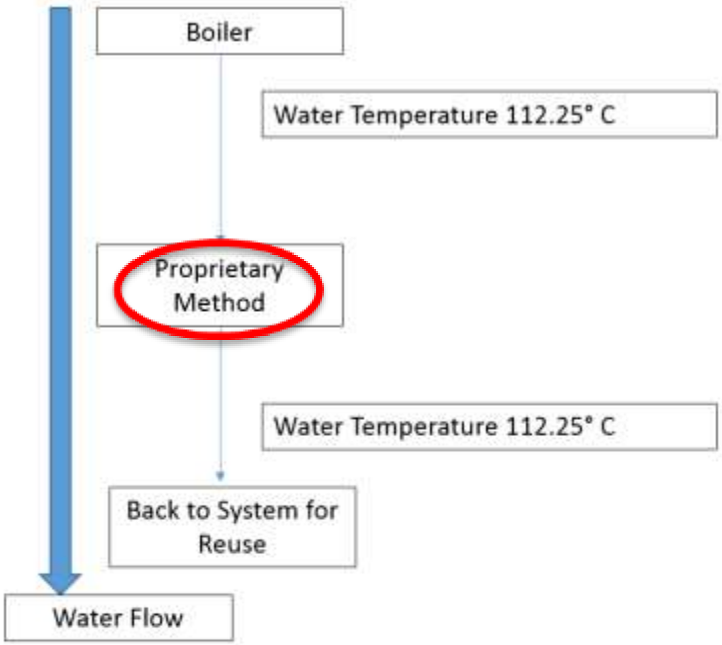

Figure 5: Flow of water for option 3

ANALYSIS: OPTION 1

Integrated HLS with RO system

- HLS recovers 99 liters out of 100 liters of water
- RO recovers 70 liters out of 100 liters of water

➢ **Integrated system recovers 69.3%**

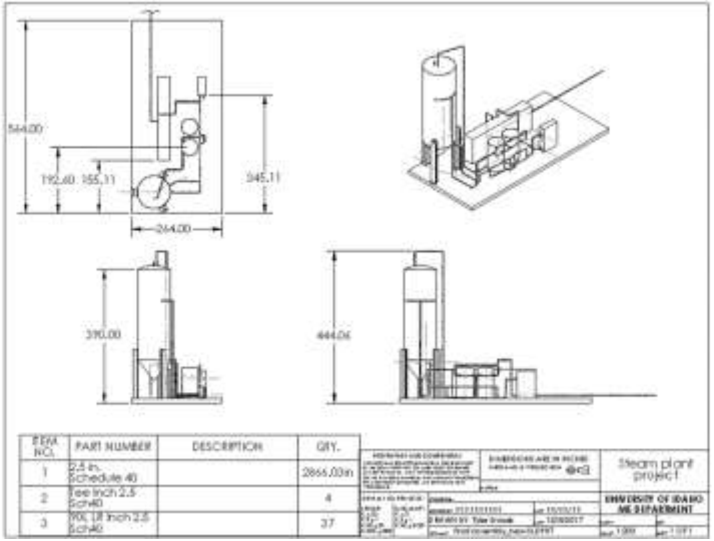

Figure 6: Schematic of HLS System

ANALYSIS: OPTION 2

Utilizing membrane filtration

Integration of UF, NF, and RO membranes

- UF system recovers 95 liters out of 100 liters of water
- NF system recovers 85 liters out of 100 liters of water
- RO system recovers 70 liters out of 100 liters of water
- ➢ **Integrated system recovers 59.5%**

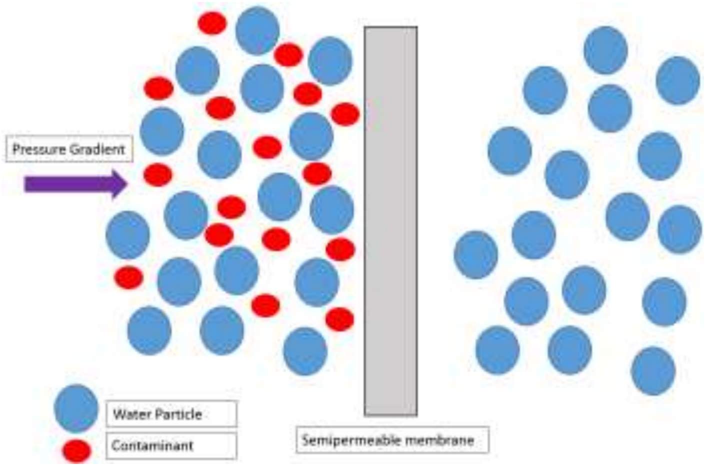

Figure 7: How Membrane Filtration Works

ANALYSIS: OPTION 3

Proprietary method based upon spherical adsorbent materials and forms

- Proprietary recovers 99 liters out of 100 liters of water
- ➢ **Integrated system recovers 99%**

Figure 8: Absorbent Materials

PROS & CONS: OPTION 1

Integrated HLS with RO system

- **Pros:**
  - The low initial investment (All equipment are available)
- **Cons:**
  - The high operating cost
  - Obsolete Technology

PROS & CONS: OPTION 2

Utilizing membrane filtration

- **Pros:**
  - Less operating cost
  - Low maintenance cost
  - Advanced Technology
- **Cons:**
  - Lowest water recovery percentage

PROS & CONS: OPTION 3

Proprietary method based upon spherical adsorbent materials and forms

- **Pros:**
  - Low operating cost
  - Lowest maintenance cost
  - Modern Technology
- **Cons:**
  - High initial cost

PERFORMANCE COMPARISON

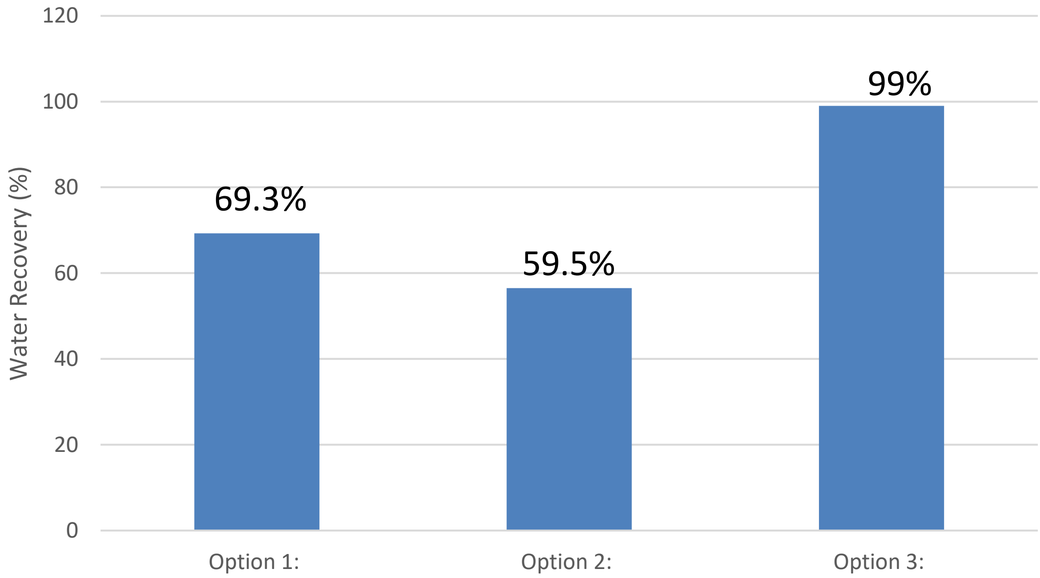

Figure 9: Water recovery of technology options

CONCLUSIONS

To reduce/eliminate the fouling and corrosion in piping and equipment:

- Suggested 3 different options for purification of the inlet water into the UI district heating & cooling:
  - Option 1: Integrated HLS with RO system, Purification **69.3%**
  - Option 2: Utilizing membrane filtration, Purification **59.5%**
  - Option 3: Proprietary method, Purification **99%**

Figure 10: Residue in the Pipe (UI Energy plant)

FUTURE STUDY

- Financial comparison of 3 options
- For all filtration alternatives:
  - Energy efficiency analysis
  - Exergy efficiency analysis

QUESTION

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