RESEARCH BRIEF
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NAWI
National Alliance for Water Innovation

Data-Driven Fault Detection and Process Control for Potable Reuse with Reverse Osmosis

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Challenge

Water stressed communities are aggressively pursuing alternative water supplies (e.g., seawater, brackish water, or potable reuse of municipal reclaimed water). Advanced purification of municipal wastewater via multi-barrier potable reuse trains such as RO-based advanced treatment (RBAT) are proven to robustly remove pathogens and chemicals resulting in a high-quality purified water. For drought-stricken utilities, it often is the most available and affordable method for generating new water supplies. With tangible benefits in hand, RBAT also has challenges. RBAT remains nearly ten times more expensive and ten times more energy-intensive than conventional water supplies at most locations (Tchobanoglous et al., Halloway et al.). In order to bridge the gap between conventional water sources and RBAT and move towards pipe parity, operational innovations are needed.

The development and implementation of advanced controls for optimization, such as machine learning (ML) and artificial intelligence (AI), is an area that is ripe for innovation. In some cases, advanced controls are built into individual processes, but the controls are not integrated across the entire system and don't account for impacts on upstream or downstream processes (Bagheri et al., Odabasi et al.). To the best of our knowledge, no studies have applied ML or AI to the operation of integrated RBAT trains in potable reuse.

Research Approach

The overall goal of this project is to lower the cost of RBAT by developing new and improving existing technological solutions to make treatment of nontraditional waters competitive with conventional water sources for specific end-use applications. Specifically, this project will:

- Conduct a thorough desktop simulation and evaluation of five fault detection and process control methods using historical high-frequency online sensor data from partner utilities.
- Screen the five methods to determine if they can achieve the technical targets of 10% energy savings, 20% cost savings, or 50% improved reliability.
- Implement and test fault detection/process controls that pass the screening at two demonstration-scale RO-based potable reuse facilities (LVMWD and OCWD).

Impact

This research intends to use ML and AI to reduce energy use, reduce chemical use, improve operational support, increase treatment system uptime, and improve confidence in purified water quality. Improved fault detection with ML could improve reliability and water availability by avoiding unnecessary shutdowns and detecting declining water quality promptly before public health is at risk. This, will in turn, reassure the public that advanced measures are being put in place to verify and maintain safe drinking water quality. Additionally, adaptive process control will save energy, lower costs and improve process adaptability to influent water quality fluctuations.

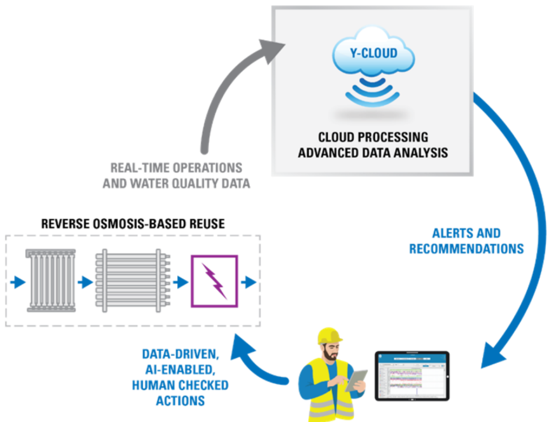

Figure 1. Cloud-based semi-autonomous fault detection & process control conceptual diagram.

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