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Oxidative Destruction of Organics in Membrane Concentrates

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Objectives:
The goal of this project is to develop a post-treatment oxidation process for removing organics in membrane concentrates. While previous projects have focused on issues associated with inorganic salts, utilities have few resources to treat organics or microbiological organisms present in membrane concentrates. Three tasks were carried out to address the goal of the project:

1. Conduct a literature review and technical comparison of the technical and economic feasibility of existing and emerging oxidation processes for treating organics in membrane concentrates;
2. Conduct bench-scale screening of oxidation processes with the greatest potential for success; and
3. Optimize the most feasible oxidation process for treating RO membrane concentrate from a wastewater reclamation facility, and identify potentially limiting factors for implementing this technology.

Summary of Findings:
Processes that produced hydroxyl radicals were capable of oxidizing DOC to purgable gases and biodegradable organics. UV/TiO_2 was selected as a sequential AOP biodegradation process because it lacks chemical reagents that could affect biological processes. UV did not leave a residual, and titanium dioxide was easily separated using membranes. To achieve the 90% DOC removal goal for this project, biodegradation was incorporated, which reduced the energy dose requirements roughly in half. Thus, the project objective was achieved.

Recommendations:

- If salt rejection is not a primary objective for wastewater reuse, treatment by AOPs alone (without membranes) could become a viable approach for controlling organics. A comparison between integrated UV/TiO_2 systems (with ceramic membranes for TiO_2 separation) and tight membrane (RO, NF) systems is worthwhile to evaluate which system achieves overall reuse treatment goals at the lowest treatment costs. Ceramic membranes are effective at removing a wide variety of oocysts and bacteria, while UV disinfection effectively inactivates many viruses.
- Continuous flow UV/TiO_2 treatment (pilot scale) systems followed by simple biological filters (activated carbon) should be evaluated for post-treatment of RO concentrate prior to discharge to the environment.
- The cost-effectiveness of removing 10%, 25%, 50%, 75%, 90%, etc. of the DOC from RO concentrate should be determined. However, it is also to pair the DOC removal cost with the incremental benefits in reduction of potential toxicity or other ecological endpoints.
- The ability of UV/TiO_2 systems to reduce toxicity, rather than simply to remove DOC and specific compounds, should be investigated. A relationship between DOC removal and toxicity reduction would serve as useful guidance for utilities attempting to set target DOC levels for discharge of RO concentrates.
- The long-term usage of TiO_2 on membrane concentrates has not been evaluated, but should be in the near future. Issues that should be addressed include: 1) long-term viability of TiO_2 structural (i.e., friability) and oxidative properties, 2) accumulation of metals on TiO_2, and 3) disposal requirements for spent TiO_2.