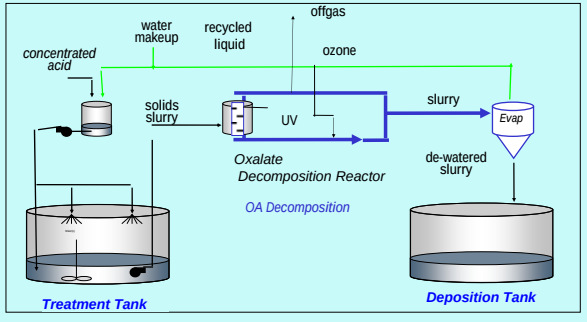
Savannah River Remediation

We do the right thing.

Enhanced Chemical Cleaning: Assessing the Significance of UV

Enhanced Chemical Cleaning Process



What's Going On?

Oxalic Acid is used to dissolve sludge waste. The resulting oxalate is destroyed using ozone and UV light.

Oxidation vs. Hydroxylation

Oxidant	Potential (V)	Rate Const. K_{C2O4} ($M^{-1}s^{-1}$)
O_3	2.86	5.3E+6
◦OH	2.07	0.04

The hydroxyl radical (◦OH) drives the decomposition rate. The radicals can be generated via several reactions[1,2]. Some require UV light.

$$O_3 + H_2O \xrightarrow{h\nu} 2\circ OH$$

$$O_3 + H_2O \xrightarrow{h\nu} H_2O_2 + O_2 \longrightarrow 2\circ OH + O2$$

$$Fe(II) + H_2O_2 \longrightarrow Fe(III) + \circ OH + OH^-$$

$$Fe(III) + H_2O_2 \longrightarrow Fe(II) + HO_2 / O_2^- + H^+$$

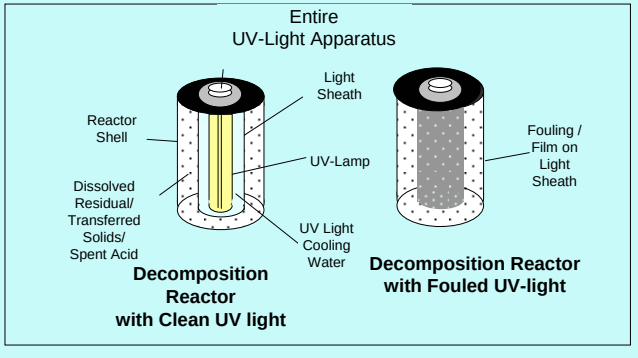
$$Fe^{2+} + O_3 \longrightarrow FeO^{2+} + O_2 + H_2O \longrightarrow Fe^{3} + \circ OH + OH^- + O_2$$

$$[C_2O_4]^{-2} + \sum [\circ OH] \rightarrow CO_2 + H_2O$$

Some Practical Considerations

- UV light is operationally difficult
- Fouling & Maintenance
- Safety related component

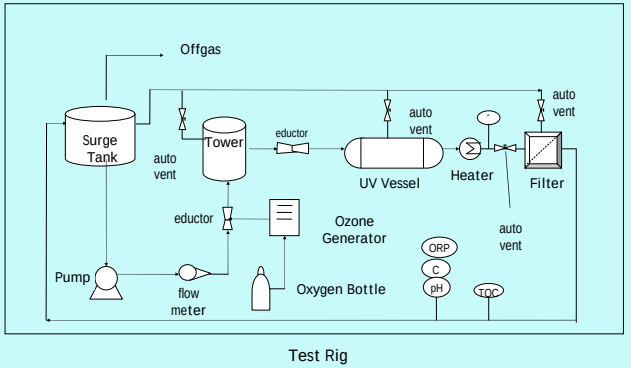
Is the UV Worth the Trouble?



Literature from similar non-radioactive chemistry shows a 10x loss in destruction rate with no UV.

Equipment Design

Test rig designed and built to determine realistic impacts at close to process conditions.

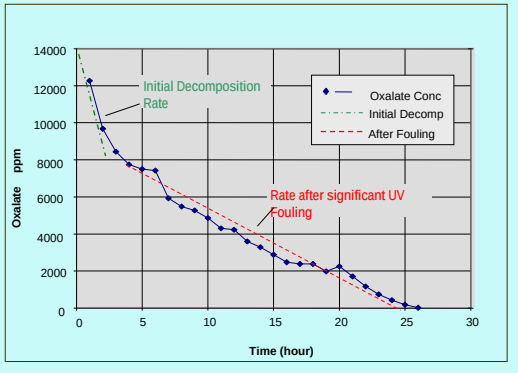


Test Rig

Procedure

Run test rig. Allow UV light to foul. Pull liquid sample every hour to measure the remaining oxalate concentration.

Results



After about 3 hours, decomposition rate decreased. Overall, there was a ~3X decrease in the destruction rate.

Future Work

Perform more detailed testing with and without UV with a broader range of conditions.

References

1) "Hydroxyl Radical Formation in Aqueous Reaction of Iron (II) with Hydrogen Peroxide: Photo-Fenton Reaction," *Env. Sci. Tech.*, Vol 26, 1992.

2) "Oxidation of Ferrous Ions by Ozone in Acidic Acid Solutions," *Inorganic Chemistry*, Vol 31, 1992.

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