Peracetic acid (PAA) and performic acid (PFA) for water disinfection

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Introduction

Peracetic acid (PAA) is one of the most used disinfectants in wastewater treatment. Also used in food industry and aquaculture.

Peracetic acid is used as commercial solution in equilibrium with hydrogen peroxide:

\[ \text{CH}_3\text{COOH} + \text{H}_2\text{O}_2 \leftrightarrow \text{CH}_3\text{CO}_3\text{H} + \text{H}_2\text{O} \]

- Does not form toxic byproducts
- Hydrogen peroxide is a weak disinfectant.
**Introduction**

**Performic acid (PFA)** is one of the most used disinfectants in food and medical industries.

Performic acid is unstable and need to synthesis before use:

\[
CH_2O_2 + H_2O_2 \leftrightarrow CH_2O_3 + H_2O
\]

(Formic acid)  (Hydrogen peroxide)  (performic acid)  (water)

- Newly introduced disinfectant to wastewater industry
- Recently used in Combined Sewer Overflow (CSO) disinfection
- Does not form toxic byproducts
Combined sewer overflow

Disinfectant profile in CSO

\[ C \cdot t = \text{area under curve} \]

\[ C_t (t=\text{HRT}) \quad C_t = C_{\text{effluent}} \]

dilution on release to surface water

3 design parameters

- \( C \cdot t = \text{effect concentration} = \text{area under curve} \)
- \( C_t = \text{concentration after retention time (t)} = C_{\text{effluent}} \)
- Residual toxicity
Quantification method of Peracetic acid (PAA) and performic acid (PFA)

• Modified spectrophotometric method with ABTS* for less $\text{H}_2\text{O}_2$ interference.
  – Mixing reagent A (ABTS) and reagent B (acetic acid buffer)

* = (2, 2’’-azino-bis [3-ethylbenzothiazoline-6-sulfonic acid] diammonium salt)
Quantification of Peracetic acid (PAA) and performic acid (PFA)

Kinetics of color development

- PAA-ABTS reaction=10 min
- Color development kinetics 2.5 mg/L PAA & 2.5 mg/L H₂O₂

Calibration curve

- PFA-ABTS reaction=20 min
- Color development kinetics 2.5 mg/L PFA & 2.5 mg/L H₂O₂
Concentration profiles

**pH effect**

- pH 8.0
- pH 7.5
- pH 4.16
- pH 7.5
- pH 5.18

**Matrix effect**

- 5% raw WW
- 15% raw WW
- 40% raw WW

**PAA**

- Slow degradation
- Matrix dependent

**PFA**

- Fast degradation
- Matrix independent
Disinfection efficiency of PAA and PFA

- 10 min contact time for *Enterococcus* inactivation.
  - Reasonable robust to matrix at 5% to 15% WW.

- Light CSO was simulated with 5% wastewater
  - PFA is effective on *Enterococcus* removal, PAA efficiency increases much more with long contact times (treatment exposure time).
Optimization of PAA without H₂O₂

- Different concentration of KMnO₄ was used for titration
- Stability of PAA was observed for 48 h
- Re-apperance of H₂O₂ was studied

Solution’s characteristics before and after titration procedure.

<table>
<thead>
<tr>
<th></th>
<th>PAA (mg/L)</th>
<th>H₂O₂ (mg/L)</th>
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<tbody>
<tr>
<td>Initial concentration</td>
<td>1160</td>
<td>150</td>
</tr>
<tr>
<td>Concentration after titration</td>
<td>1010</td>
<td>1.5</td>
</tr>
<tr>
<td>Removal</td>
<td>12.9%</td>
<td>99%</td>
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PAA and H₂O₂ measured at the end of titration with different concentrations of KMnO₄

\[ y = -0.003x + 1.1 \]

\[ R^2 = 0.936 \]
Schematic diagram of RAS

- **NH₃**
- **Biological filter**
- **Pump**
- **Disinfectant**

Diagram showing a process involving fish tanks, a pump, a biological filter, and a disinfectant system.
WATER, SANITATION, POLLUTION AND HEALTH IN THE ARCTIC

Treatment of Arctic wastewater by chemical coagulation, UV and peracetic acid disinfection

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Thank you for your attention