Organic load removal from swine breeding wastewater using electrochemical oxidation

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Why is this research important

High amounts of wastewater are generated in intensive swine farms needing an adequate treatment to meet environmental regulations.

State of the art

Multiple technologies have been applied to swine wastewater remediation in large farms, but due to several drawbacks alternative technologies are needed.

Experiment

Our experiment was designed to use graphite electrodes to degrade organic pollutants electrochemically.

Conclusion

We demonstrated that electrochemical oxidation is an effective technology to treat swine wastewater.
Electrooxidation involves the transfer of one or more electrons from the substrate to the anode.

**Electrooxidation mechanism**

The mechanism of oxidation in graphite anodes is explained as that of an active anode!


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**Pollutant oxidation**

**Graphite electrodes**

**H₂ Production**
Objectives (1/1)

Is electrooxidation effective for the treatment of SW and which factors affect process performance?

1) **Swine wastewater characterization** in order to obtain an updated knowledge on wastewater wet chemistry

2) **Electrooxidation** of the organic substrate to study the effects of process parameters.

3) **Statistical analysis** to compare the results obtained under different factor levels

Swine breeding wastewater

Bulk electrolysis experiments
Taguchi Method

• Factors: Initial pH, Current density, Reaction time
• COD decay as response variable

1) L9 Orthogonal array

2) S/N ratio calculation

<table>
<thead>
<tr>
<th>Problem type</th>
<th>Ideal target function value</th>
<th>$S/N$ ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimization Problem</td>
<td>0</td>
<td>$-10 \log_{10} \left( \frac{1}{n} \sum_{i=1}^{n} y_i^2 \right)$</td>
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<tr>
<td>Target Value Problem Type I</td>
<td>$\neq 0$, finite</td>
<td>$10 \log_{10} \left( \frac{\mu^2}{s^2} \right)$</td>
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<tr>
<td>Target Value Problem Type II</td>
<td>finite</td>
<td>$-10 \log_{10} (s^2)$</td>
</tr>
<tr>
<td>Maximization Problem</td>
<td>$\infty$</td>
<td>$-10 \log_{10} \left( \frac{1}{n} \sum_{i=1}^{n} \frac{1}{y_i^2} \right)$</td>
</tr>
</tbody>
</table>

3) Effects plot and 3D surface plot
S/N ratio for each factor level elucidate the relationship between COD reduction and the studied factors

Higher S/N ratio means higher COD removal!

1) Initial pH  
2) Current density  
3) Reaction time

The best factor combination corresponded to the initial pH = 8, the current density $= 53.1 \text{ mA.cm}^{-2}$, and the reaction time $= 45 \text{ min}$.
Natural swine wastewater pH leads to higher COD removals

3D surface plot and contour map showing the interaction between Initial pH and Current density
COD reduction increases with the increase in current density

3D surface plot and contour map showing the interaction between Current density and Reaction time
Electrolysis time promotes organics degradation in swine wastewater

3D surface plot and contour map showing the interaction between Initial pH and Reaction time
In this work, the treatability of swine wastewater by electrochemical oxidation was tested using graphite anodes.

- Swine wastewater presents **suitable characteristics** to be used in electrolysis without the addition of a background electrolyte.

- The **best factor combination** corresponded to an initial pH = 8, a current density = 53.1 mA.cm\(^{-2}\), and a reaction time = 45 min.

- Electrochemical oxidation can be considered as an **alternative for the waste management** in swine farms.
Acknowledgements

Fundação para a Ciência e a Tecnologia (Portugal) for financial support regarding the grant SFRH/BDE/111878/2015.

…and thank you for your attention!