Organic load removal from swine breeding wastewater using electrochemical oxidation

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Introduction (1/2)

Exploring how electrochemical oxidation can degrade COD on swine effluents

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

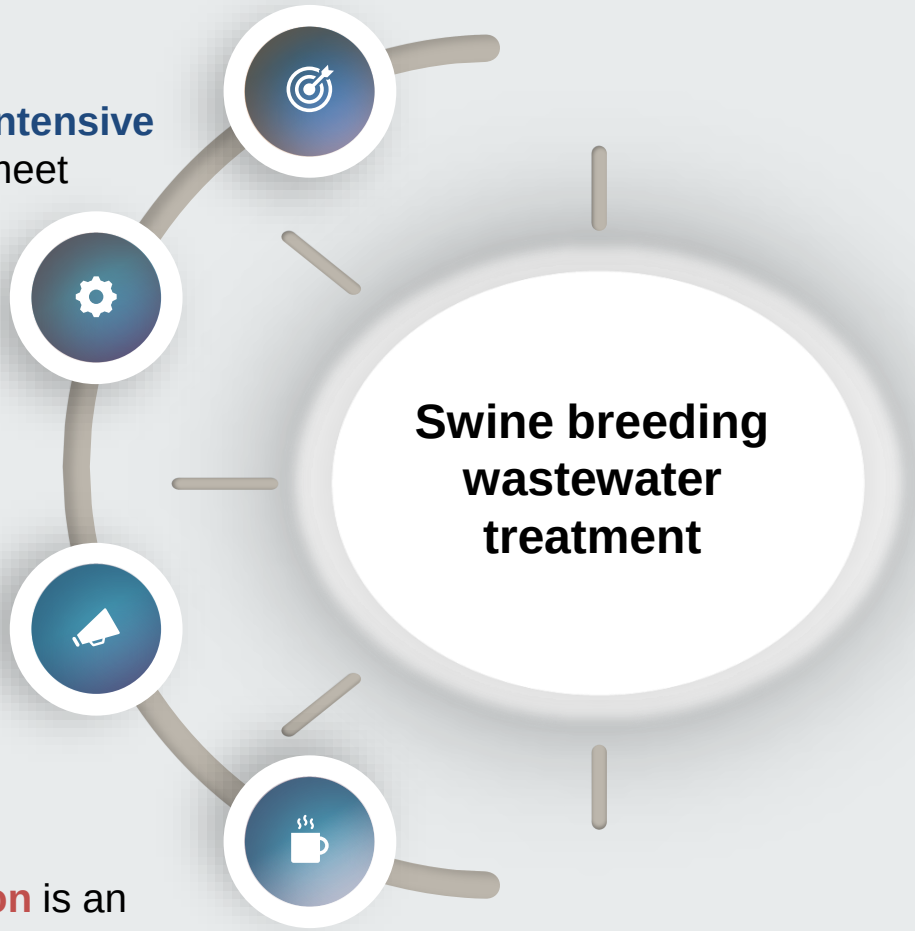
Multiple technologies have been applied to swine wastewater remediation in large farms, but due to **several drawbacks** alternative technologies are needed.

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



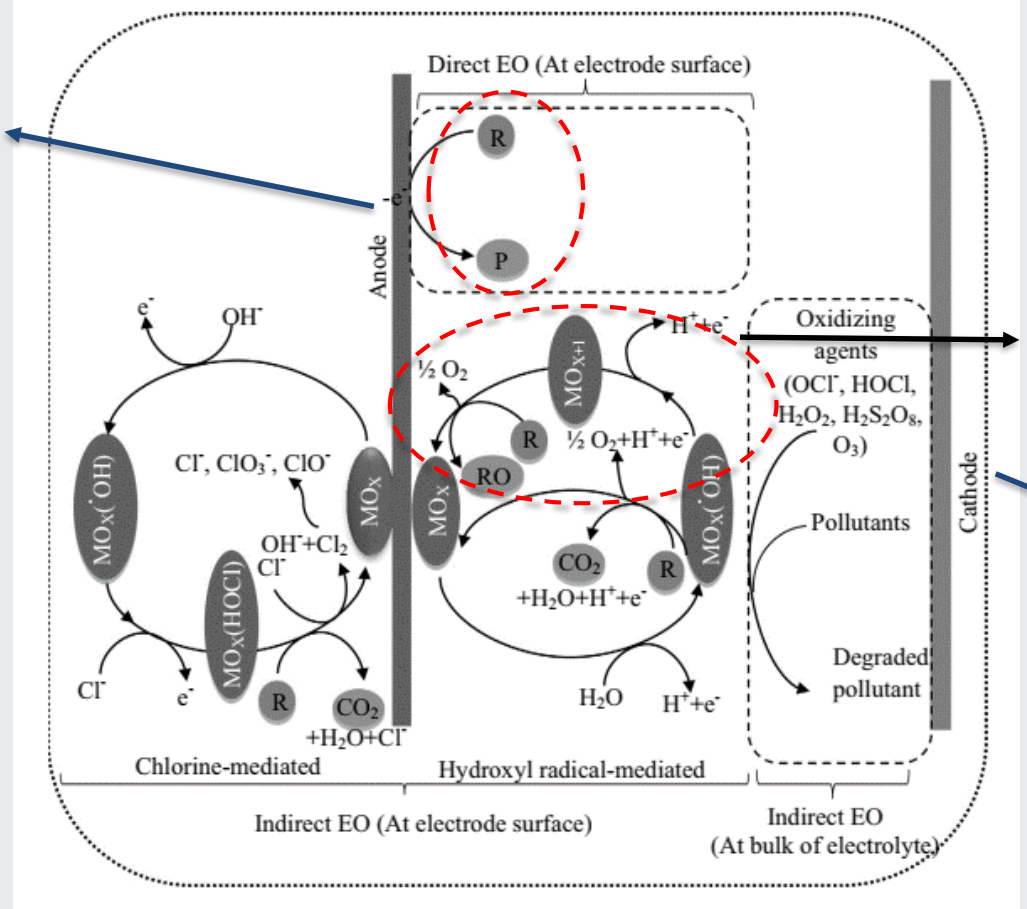
Introduction (2/2)

Electrooxidation involves the transfer of one or more electrons from the substrate to the anode

Electrooxidation mechanism

Pollutant oxidation

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



P. Mandal, B. K. Dubey, and A. K. Gupta, *Waste Manag.*, 69, 250–273, 2017.

Graphite electrodes

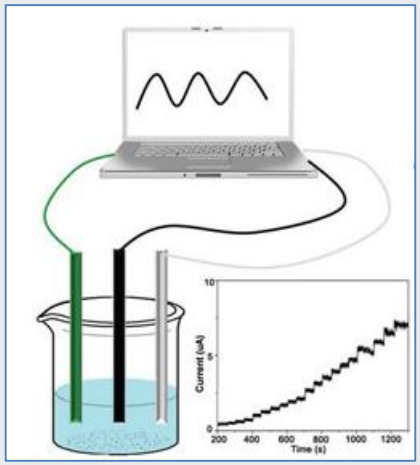
H_2 Production

Objectives (1/1)

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

Swine breeding wastewater

Bulk electrolysis experiments



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

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

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

Experimental (1/1)

Taguchi design / Methods in the study of COD reduction in swine wastewater electrolysis

Taguchi Method

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

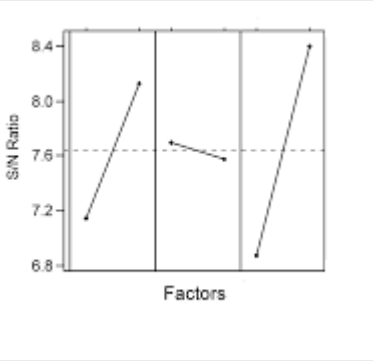
1) L9 Orthogonal array

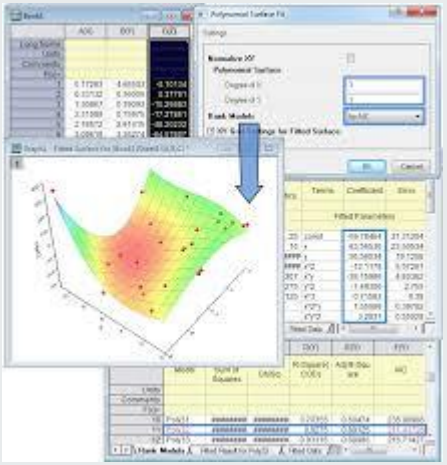
CONDITION \ COLUMN	L_9		
	1	2	3
1	1	1	1
2	1	2	2
3	1	3	3
4	2	1	2
5	2	2	3
6	2	3	1
7	3	1	3
8	3	2	1
9	3	3	2

2) S/N ratio calculation

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

3) Effects plot and 3D surface plot





Results (1/4)

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 mA.cm^{-2}, and the reaction time = 45 min.

Results (2/4)

Natural swine wastewater pH leads to higher COD removals

3D surface plot and contour map showing the interaction between Initial pH and Current density

Results (3/4)

COD reduction increases with the increase in current density

3D surface plot and contour map showing the interaction between Current density and Reaction time

Results (4/4)

Electrolysis time promotes organics degradation in swine wastewater

3D surface plot and contour map showing the interaction between Initial pH and Reaction time

Summary and Conclusions (1/1)

Electrochemical oxidation can be used as an alternative technology for swine wastewater treatment

In this work, the treatability of swine wastewater by electrochemical oxidation was tested using graphite anodes

SW Electrochemical oxidation

Initial pH | **Current density** | **Reaction time**

- 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!