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Title: Effect of electrode configuration on physicochemical parameters during textile dye degradation by plasma in an air-water system

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Introduction

- Persistent dyes in wastewater are toxic and resist conventional treatments, harming aquatic ecosystems.
- Plasma-based AOPs generate reactive species that break down pollutants without added chemicals.
- Electrode geometry and material affect discharge stability, energy efficiency, and degradation performance.
- Compare four electrode configurations to identify the most efficient setup for dye degradation.

Objective of the experiment

To evaluate the effect of different electrode configurations on the degradation efficiency of Dark Blue 628 dye using atmospheric air plasma.

Methodology

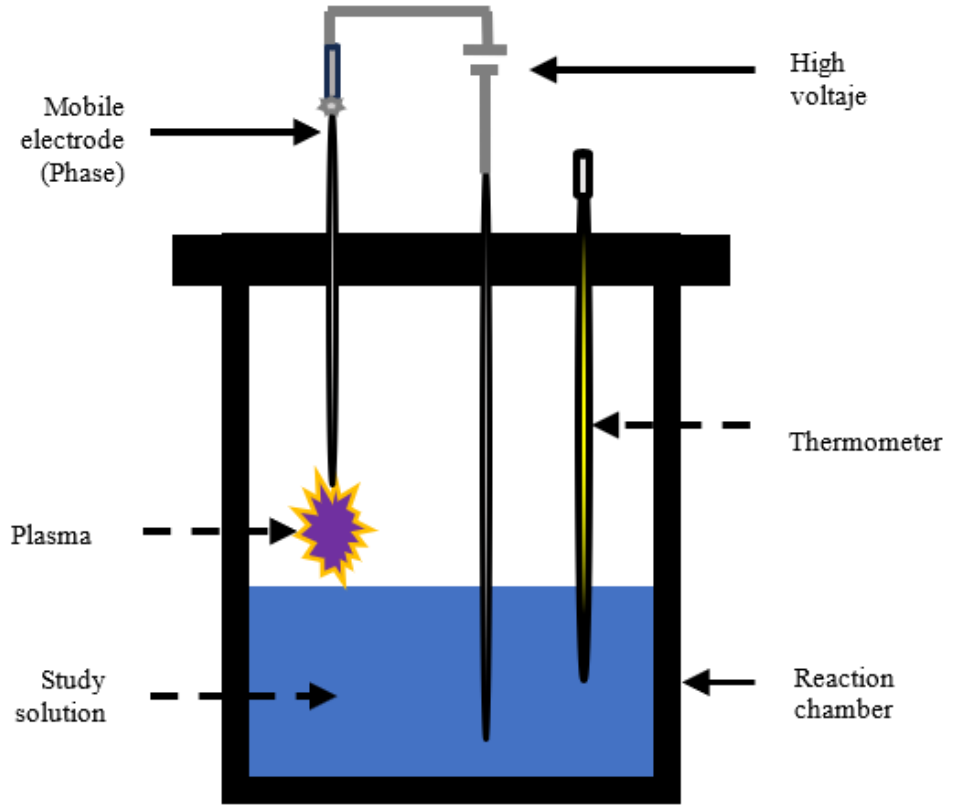


Figure 1

Experimental setup. Configuration 1. Parallel point-to-point electrodes. Tungsten tips.

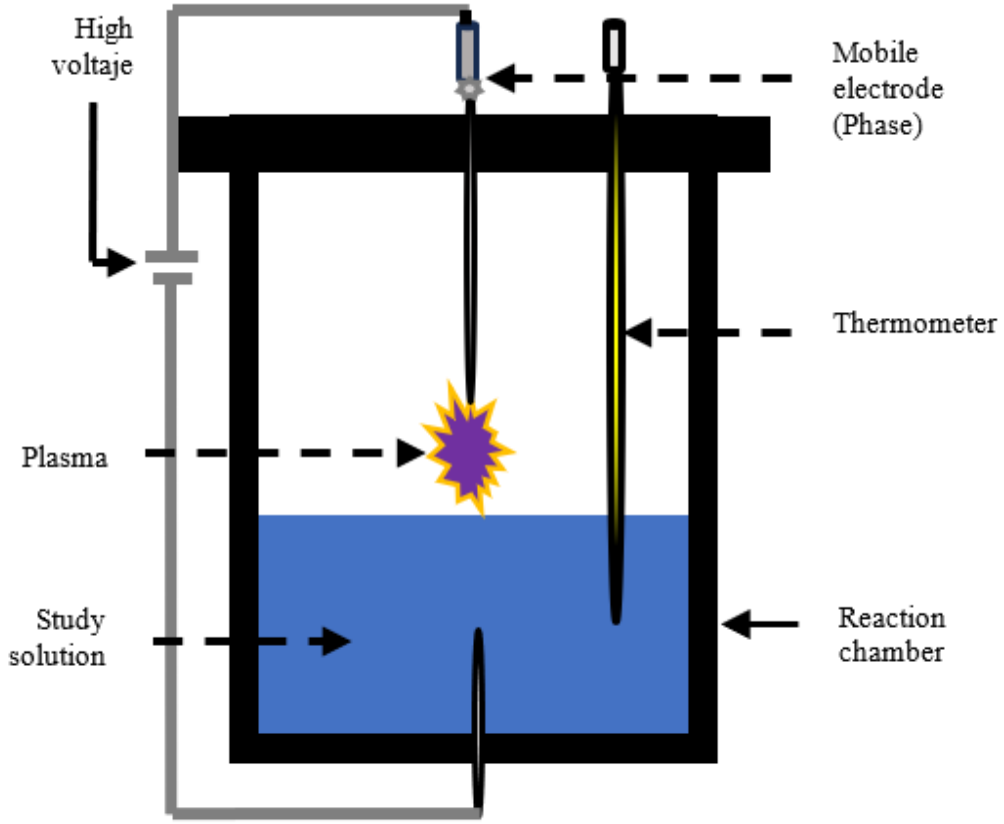


Figure 2

Experimental setup. Configuration 2. Converging point-to-point electrodes. Tungsten tips.

Methodology

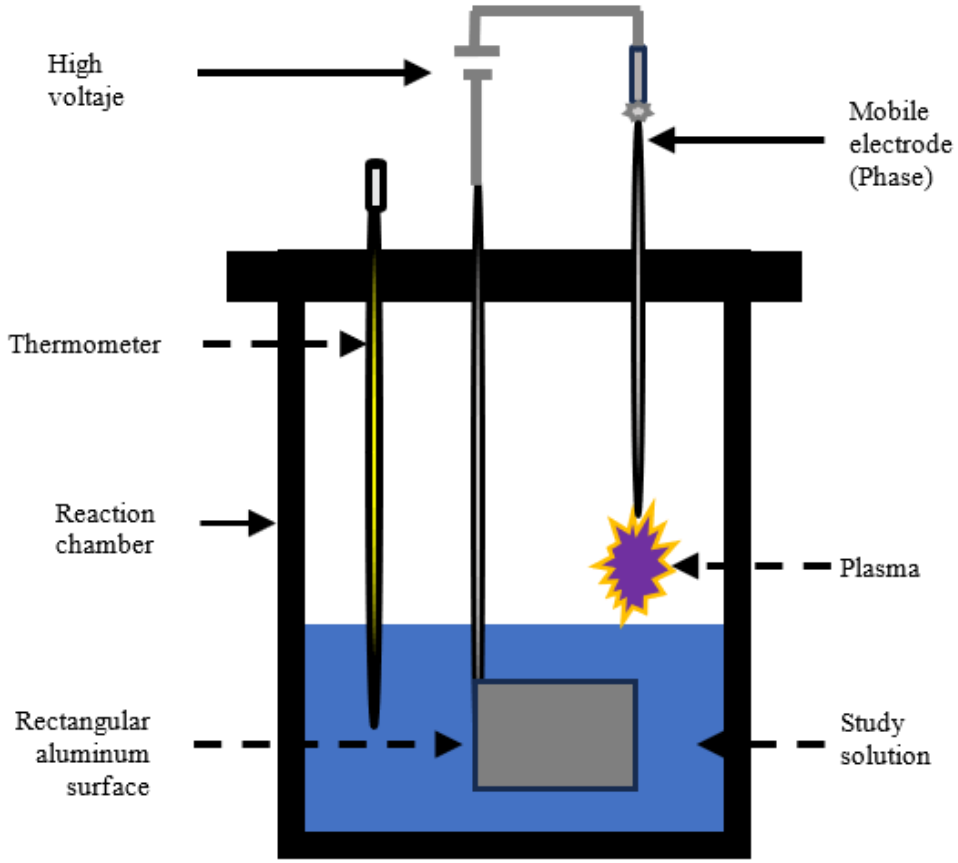


Figure 3

Experimental setup. Configuration 3. Point-to-vertical surface. Tungsten tip, aluminium surface (24.5 cm^2).

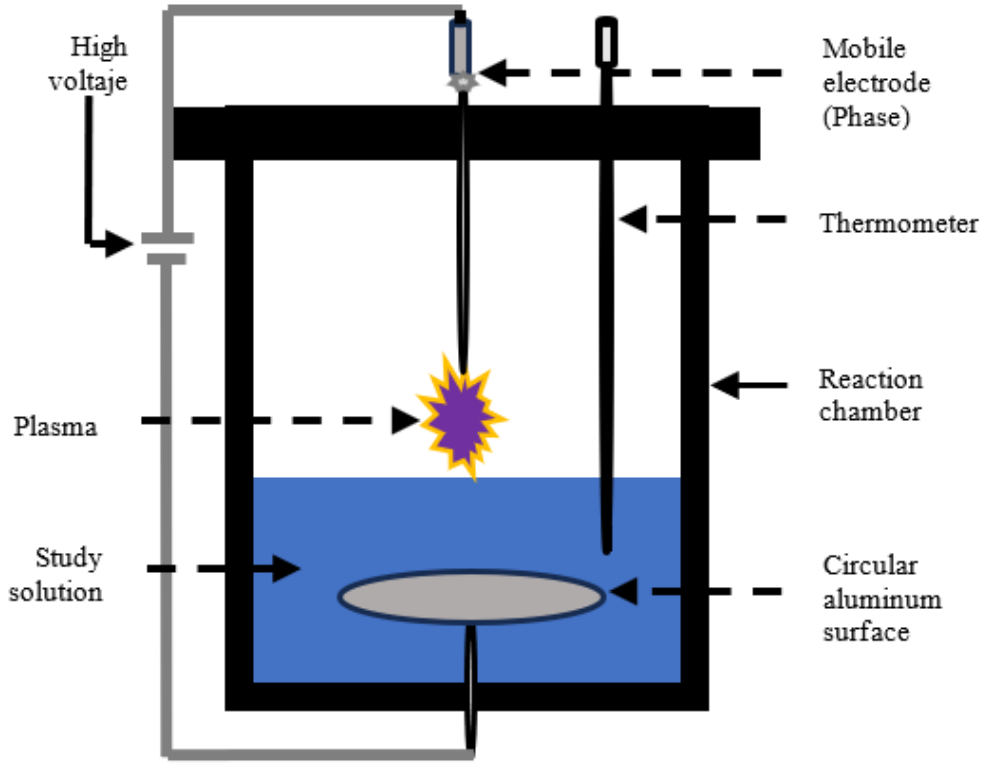


Figure 4

Experimental setup. Configuration 4. Point-to-horizontal surface. Tungsten tip, aluminium surface (19.6 cm^2).

Methodology

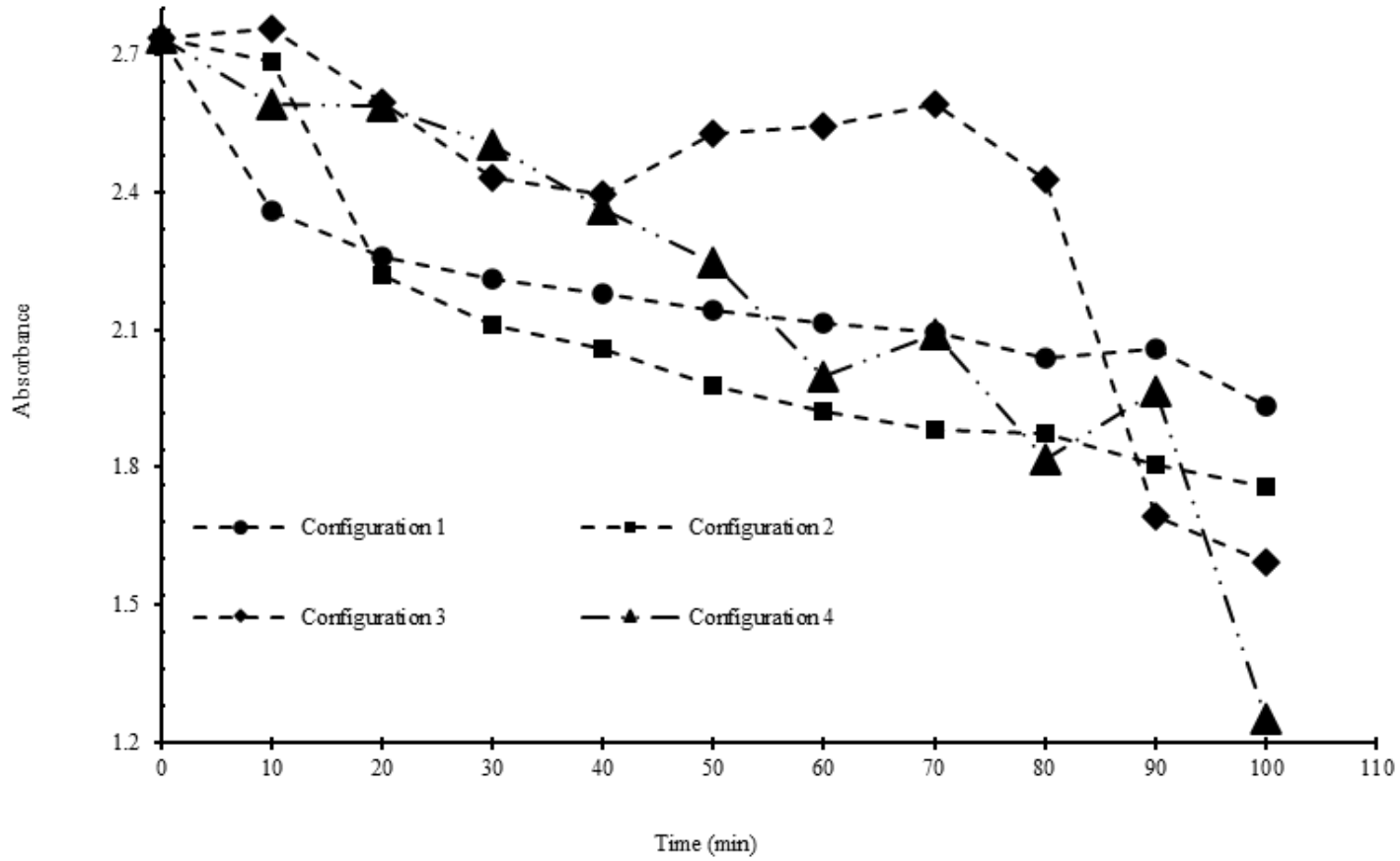
Four electrode configurations were tested: parallel point-to-point, opposite point-to-point, vertical point-to-surface, and horizontal point-to-surface.

Each configuration operated at 5000 V and 50 mA for 100 minutes.

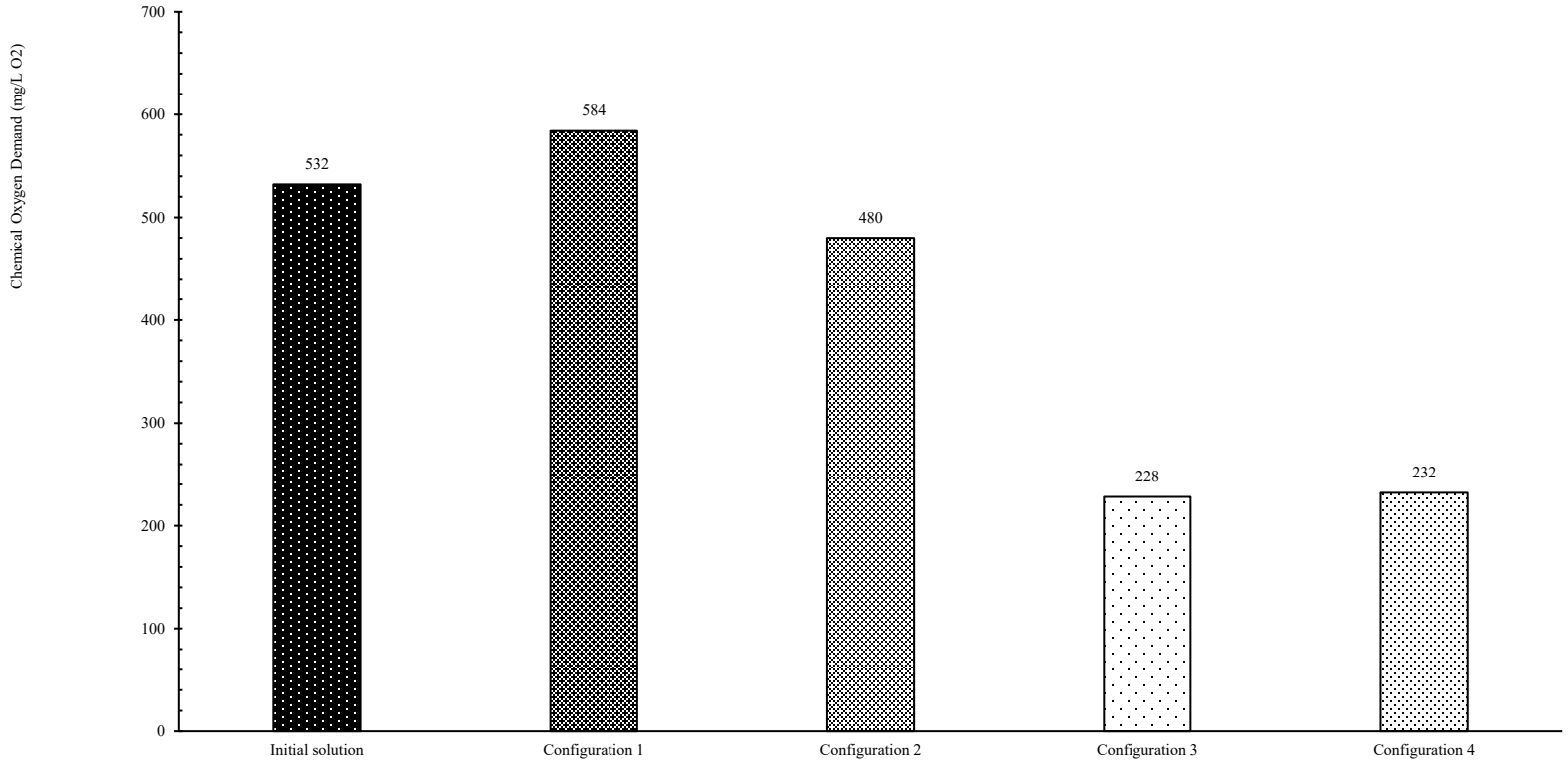
Using a 350 mL dye solution.

Results

The results for temperature, absorbance, pH, chemical oxygen demand, temperature and total dissolved solids are presented.

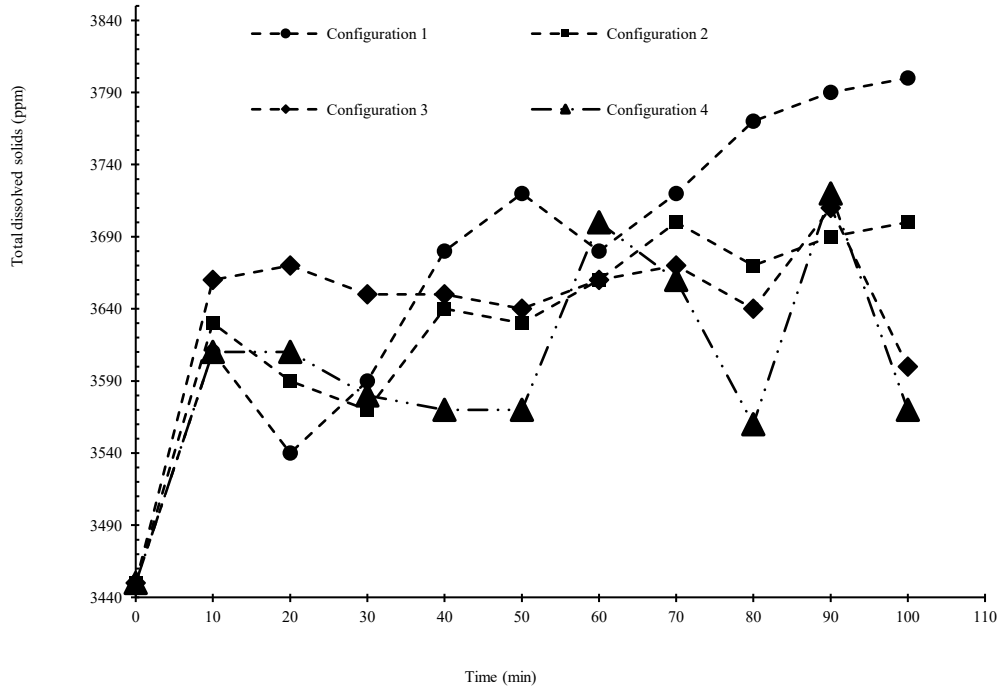


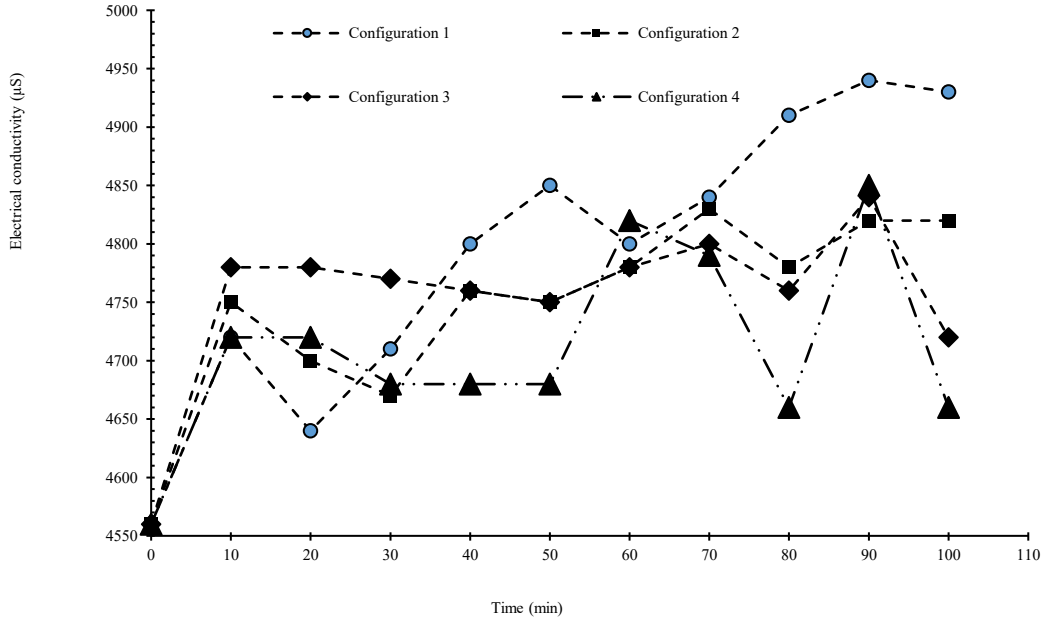
Absorbance decreased progressively in all configurations. The tungsten-aluminum combinations (Configurations 3 and 4) achieved the highest degradation efficiency (>95%), showing strong influence of electrode material and geometry.

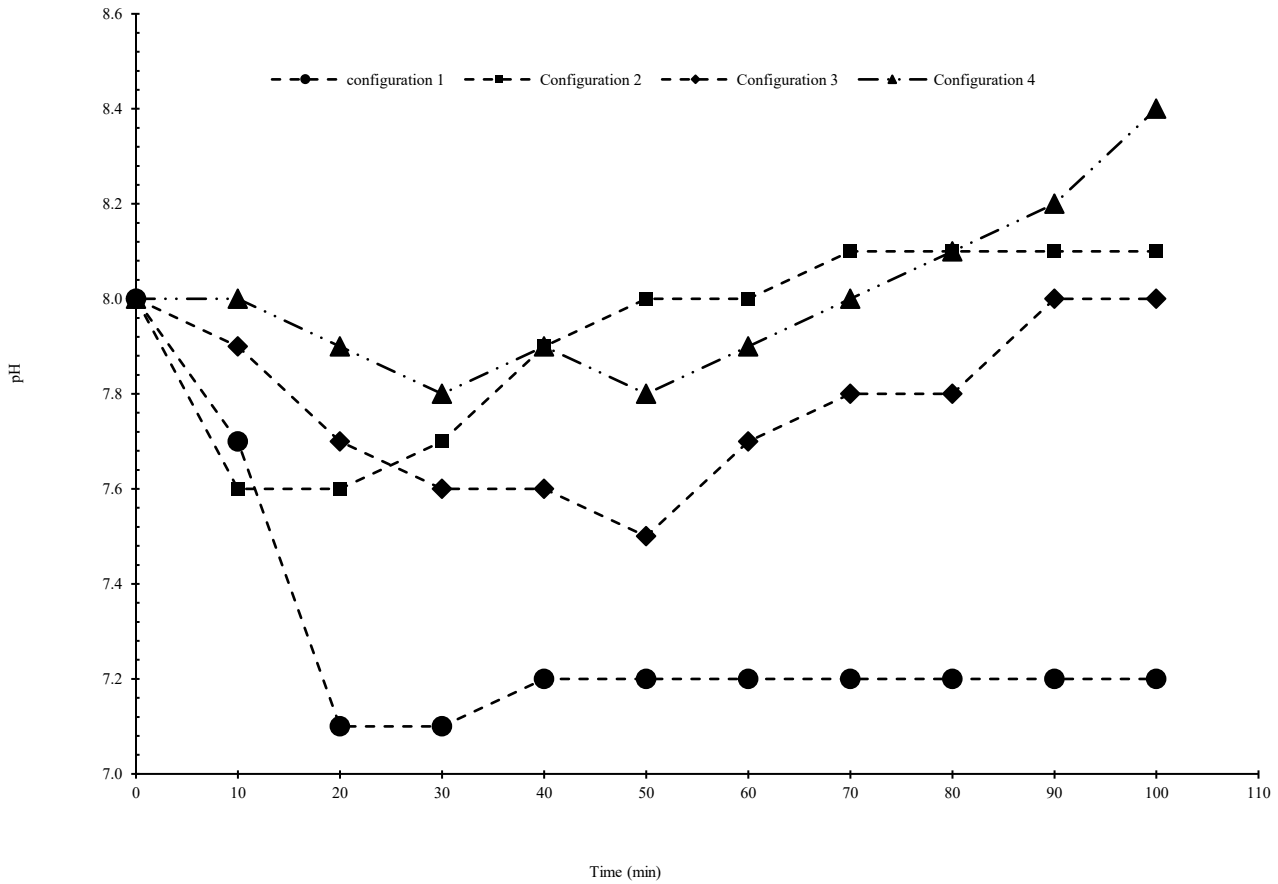


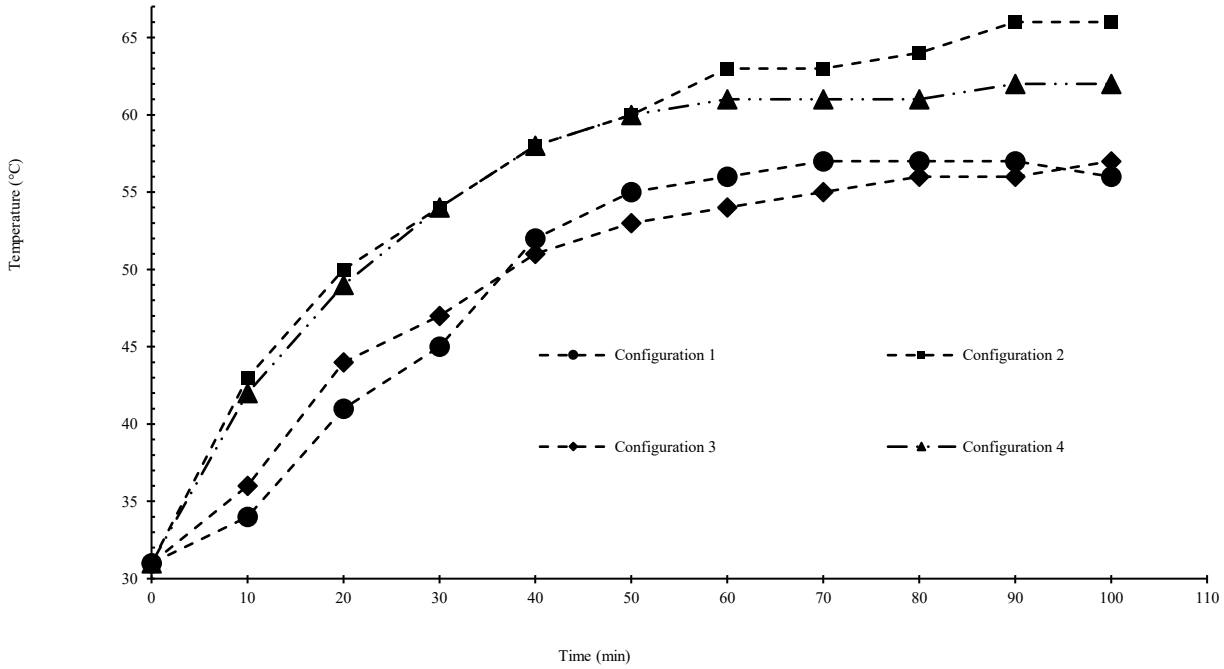
Chemical Oxygen Demand (COD) decreased up to 56% in mixed electrode setups, indicating enhanced mineralization through plasma-induced oxidation and aluminum hydroxide coagulation effects.

Configurations with aluminum showed increased pH due to basic species formation, while Total Dissolved Solids and Conductivity stabilized, indicating precipitation of aluminum hydroxides.






configuration 1
Configuration 2
Configuration 3
Configuration 4
pH
Time (min)
8.6
8.4
8.2
8.0
7.8
7.6
7.4
7.2
7.0
0
10
20
30
40
50
60
70
80
90
100
110



Temperature rose throughout plasma exposure. Opposed and horizontal configurations (2 and 4) reached higher temperatures, enhancing oxidation kinetics.

Conclusions

This study demonstrates the effectiveness of atmospheric pressure non-thermal plasma treatment in degrading the commercial, dark blue 628 dye in aqueous solution.

Mixed tungsten-aluminum electrode systems and geometries that maximize plasma-liquid interaction achieved the best degradation performance. Air plasma proved effective for dye removal without chemical additives.

Four electrode configurations with different geometries and materials (tungsten and aluminium) were evaluated, showing that both the electrode arrangement and material significantly influence the oxidation and removal processes of the contaminant.

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