Degradation of Orange II in water by gas-liquid nsp-DBD plasma

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Introduction/Motivation

Textile dyes represent some of the most complicated environmental pollutants due to their variety and complex structure. Plasma oxidation methods have emerged as viable techniques for effective decomposition of these pollutants[1]. Orange II is a widely used synthetic azo dye. It does not decompose through biological methods, and resists light irradiation and chemical oxidation. It is generally used as a model substrate for the aromatic azo dyes. Therefore, several scholars have studied its degradation. [2] So far, many techniques have been applied for dyeing wastewater degradation, such as adsorption, chemical, membrane degradation and the combined treatment of different methods. Among them, plasma treatment is one of the most promising technologies with high efficiency for wastewater treatment[3].

Objectives

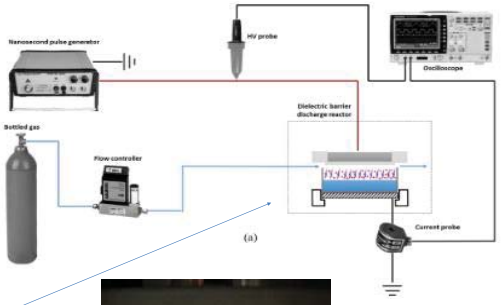
- **Examination** of the applicability of **Cold Atmospheric Plasma (CAP)** discharge techniques as advanced oxidation methods for the efficient, sustainable and cost-effective remediation of water contaminated by Orange II.
- **Testing** of a gas-liquid **dielectric barrier discharge (DBD)** reactor operating with air at atmospheric pressure to investigate the removal of Orange II from water solutions.
- **Investigation** of the role of (i) treatment time; (ii) voltage amplitude; (iii) pulse frequency; (iv) flow rate on the Orange II degradation efficiency.

Experimental procedure/Experimental setup

- ✓ Water is contaminated by commercial Orange II (>99% purity) with initial concentration: 40 mg/L
- ✓ Contaminated water sample (15ml) is placed in plate above the grounded electrode.
- ✓ Dry air is streamed into the reactor at constant flow rate.
- ✓ Water solution samples are treated by DBD at i) various pulse frequencies (100-300 Hz) ii) various applied voltages (23.8-31.4 kV) and iii) various flow rates (0.1-1L/min).
- ✓ Treatment times range from 2 to 20 minutes.

In order to identify the degradation efficiency of Orange II after CAP treatment, the samples are analyzed by Ultraviolet–visible spectroscopy (UV-Vis). Degradation percentage was followed spectrophotometrically by the measurements of absorbance at λ=484nm.

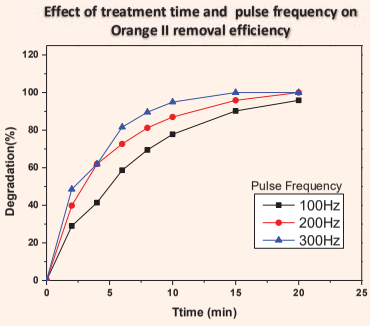
Experimental setup used to treat the Orange II contaminated water solution

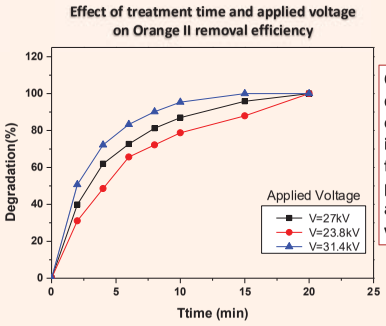


DBD reactor

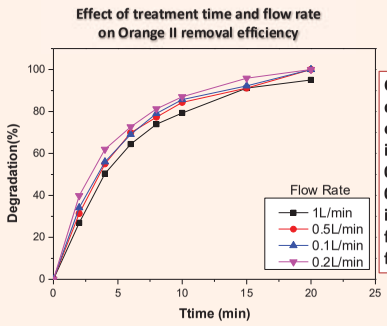
Internal view of the DBD reactor

Main Results





Orange II degradation efficiency is an increasing function of the pulse frequency and applied voltage.



Orange II degradation efficiency increases from 0.1L/min to 0.2L/min and then is a decreasing function of the flow rate.

Conclusions

- Voltage amplitude and discharge frequency affect substantially the Orange II degradation efficiency.
- The optimum air flow rate was found to be 0.2 L/min.
- Orange II is significantly removed (>50%) by CAP within 6 minutes whereas a respectable degradation efficiency is achieved (>80%) after 15 minutes of treatment in all examined conditions.
- Orange II is completely removed after 15 minutes of CAP treatment at applied voltage 31.4kV and pulse frequency of 200 Hz.
- Plasma treatment is highly effective towards the removal of Orange II from aqueous solutions in short time.

References

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3. M.A. Malik, A. Ghaffar, S.A. Malik,Plasma Sour. Sci. Technol. 10 (2001) 82–91,.