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Degradation of basic red 46 dye from color wastewater using cold atmospheric plasma

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Abstract

Contamination of groundwater with colored and toxic wastewater causes many environmental problems and has adverse effects on human health. In this study decolorization of textile dye, basic red 46, was studied using advanced oxidation processes (AOPs) in a non-thermal plasma reactor. The reactor is based on pin-to-water high-voltage corona discharge by using a high voltage AC power source and air flow. The rate of the dye removal for 100 ml of this solution was investigated. The results showed that the corona discharge exhibited 85 % of degradation efficiency for 50 mg/l of basic red 46 within 30 min of treatment time was achieved.

Keywords: Corona Discharge, Basic Red 46 Dye, Degradation

Introduction

Due to the water crisis, the development of innovative and clean advanced oxidation processes for the decomposition of harmful organic compounds in wastewater has become a major challenge for many research teams. Cold discharge plasma is one of the most widely studied and developed processes due to its low energy cost and easy operation [1,2].

In recent years the use of discharge plasma for the elimination of pharmaceutical products, synthetic dyes, and pathogenic bacteria in wastewater have received increasing attention and development [3-5].

In this research, corona discharge has been adopted for decolorization Basic Red 46 dye from aqueous solution, which is not removed by conventional methods such as electrocoagulation.

Experimental

The Basic dye used as textile dye in the present study is C.I. Basic Red 46 (Mr = 357.5), which was purchased from Isfahan Pakhsh Novin Chemical Company. The Basic Red 46 molecular structure is shown in Figure 1.

The dye solution was prepared at a concentration of 50 mg/L. A 100 mL of the Basic Red 46 aqueous solution was used as a treated sample volume.

The reactor made of cylindrical glass container consists of four tungsten pins of diameter 3 mm. (Figure 2). By injecting air, it is possible to form plasma on all pins.

The high voltage AC power supply (~15 kV) was used to ignite the plasma plume between the pins and aqueous surface in the reactor.

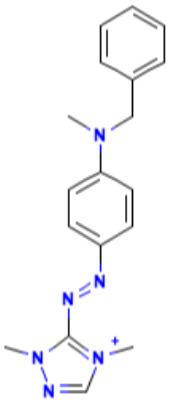

Figure 1. Basic red 46 chemical structure [6].

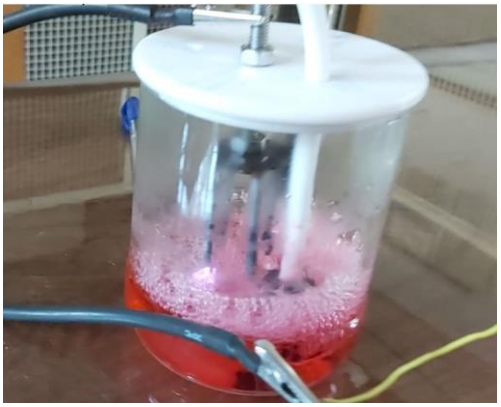

Figure 2. Pin-to-water corona discharge reactor.

Results and discussion

The dye was treated with corona array and its degradation was monitored by UV–vis absorption spectroscopy. Time dependent absorption spectra of plasma treated Basic Red dye is given in Figure 3, from which it is understood that Basic Red 46 dye exhibits maximum absorption peak at 530 nm, which can be used to monitor the degradation process.

Figure 4 shows the absorption peak ratio (A/A_0) of the tested dye solutions over the duration of the experiment (55 min). A_0 is the peak absorption of control solution. The decolorization rate of Basic Red was higher at the beginning (up to 30 min), and then, it increased at a lower rate from 30 to 55 min.

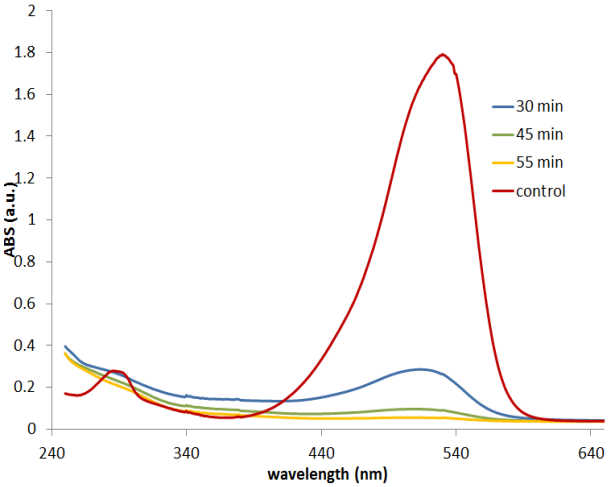

Figure 3. Absorbance of Basic Red 46 dye solution without (control) and with (30, 45, 55 minutes) plasma treatment.

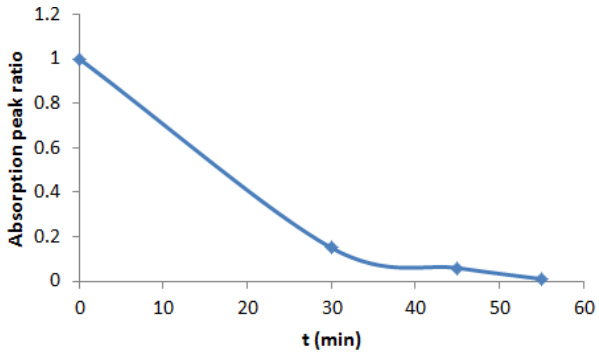

Figure 4. Time variation of decreased concentration.

Figure 5 shows the variation of the Basic Red 46 solution color with treatment time at a discharge voltage of 15 kV. The increase of treatment time results in better decolorization. The color of the water solution is almost completely decolored after 55 min treatment.

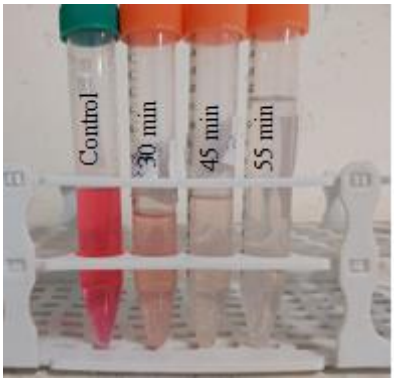

Figure 5. The variation of Basic Red 46 solution color with the processing time.

Conclusions

The corona plasma array discharge reactor system has been designed and tested for degradation of Basic Red 46 textile dyes in aqueous solution. The maximum decolorization rate (85%) was found in the first 30 minutes. Whereas, in general, chemical and physical discoloration methods have been used to remove dye from effluents, such as coagulation and flocculation processes, which are mainly used to treat textile wastewater. But these methods simply transfer dyes from liquid to solid. The phase that causes secondary pollution (i.e. sludge) and therefore requires further treatment steps [7]. It can be concluded that non-thermal plasma reactor is more effective for the decolorization of common concentrations of dye in textile wastewater.

References

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