Photocatalytic degradation of Reactive Red 195 in aqueous solutions by two types of titania catalysts

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Introduction

- Textile dyes and other industrial dyestuffs constitute one of the largest environmental pollutants [1].
- Biological treatment methods are ineffective for decolourization and degradation and other methods like chlorination or ozonation proceed in slow rates and at high costs [2].
- Advanced oxidation processes (AOPs) proved to be efficient techniques for the decolourization of dye wastewaters. Among AOPs, heterogeneous photocatalysis using TiO_2 as photocatalyst appear the most emerging destructive technology due to its efficiency in mineralization and the mild conditions required. Moreover, TiO_2 is largely available, inexpensive, non-toxic and show relatively high chemical stability [3].

Aim of this study

- The aim of this study was to examine various effects of naturally occurring chemical substances with an impact on the efficient degradation of an azo-dye using TiO_2 heterogeneous photocatalysis.

Materials & Methods

Catalysts:

- PK10 (anatase, mixture of crystalline TiO_2 and amorphous hydrated TiO_2, BET specific surface area 250-300 m^2/g)
- PK180 (anatase, crystalline TiO_2, BET specific surface area 10-13 m^2/g)

Degradated compound:

- Reactive Red 195 (RR195) (azo-dye)

Initial concentrations:

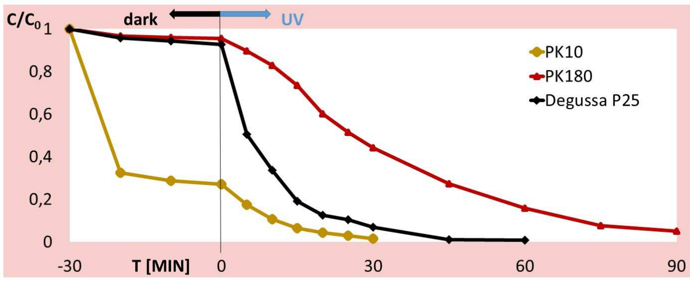
- RR195: c = 50 mg/L
- PK10 and PK180: c = 400 mg/L

Other conditions:

- UV-A lamp (9 W) with λ between 340 and 400 nm
- reaching a uniform adsorption – 30 min in darkness
- all withdrawn samples were filtered (0,45um)
- quantitative determination performed with a UV-Vis spectrophotometer

Results and discussion

Fig. 1.: Photocatalytic degradation of RR195.



The photocatalytic degradation of most organic substances follows first order kinetics [2, 4].

Fig. 2.: Effect of humic acids concentration on the rate constant.

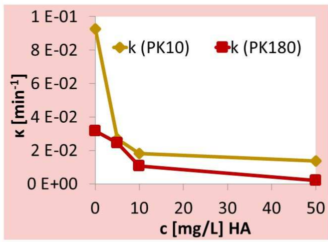


Fig. 3a, b: Effect of inorganic ions on the degradation efficiency of PK10 and PK180.

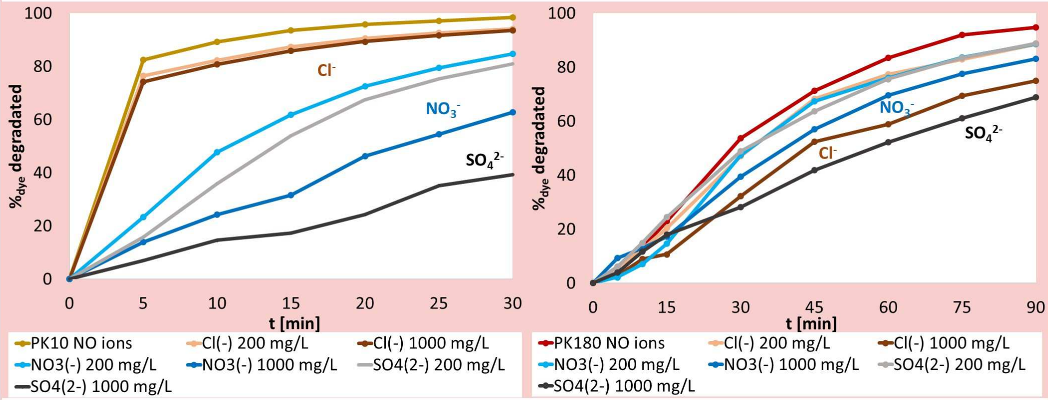


Fig. 4: Total organic carbon (TOC) reduction

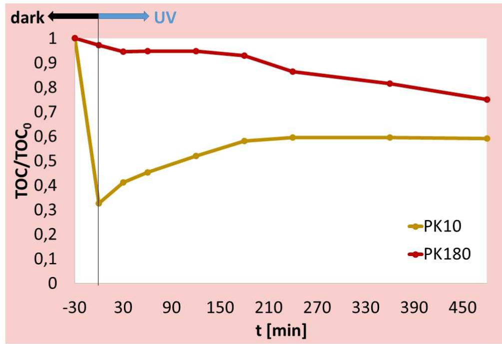


Table 1: The effect of the addition of three different scavengers used as hydroxyl, superoxide radicals, holes and singlet oxygen inhibitors [5].

PK 10		
Scavenger	k (min^{-1})	R^2
no scavenger	0,0941	0,99
iso-propanol	0,0630	0,96
p-benzoquinone	0,0529	0,99
oxalic acid	0,0673	0,99
PK 180		
Scavenger	k (min^{-1})	R^2
no scavenger	0,0315	0,98
iso-propanol	0,0058	0,98
p-benzoquinone	0,0218	0,096
oxalic acid	0,0059	0,97

Conclusions

- **Strong adsorption in case of PK-10 exhibited.**
- **Minimum adsorption in case of PK-180 spotted.**
- **Good photocatalytic activity performed. - Almost 95% decolourisation/degradation of the dye within 30 and 90 minutes for both catalysts PK-10 and PK-180, respectively.**
- **Addition of HA, inorganic ions or scavengers causes a decrease of the decolourisation/degradation rate, in general.**

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