Supplementary material

**Sulfate radicals based degradation of the antraquinone textile dye in a plug flow photoreactor**

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TABLE I. General characteristic of RB 19 dye

|  |  |
| --- | --- |
| **Properties** | **Dye** |
| Commercial name | Remazol Brilliant Blue R |
| C. I. number | 61200 |
| Apparent color | Blue |
| Purity | ~ 50 % |
| Molecular weight | 626 g mol-1 |
| Molecular formula | C22H16N2Na2O11S3 |
| Chemical structure |  |
| Maximum absorption wavelength | 592 nm |
| Water solubility | 10 g dm-3 |



Figure 1. Scheme of irradiation system with plug flow reactor



Figure 2. UV/Visible spectral changes during UV/S2O82- treatment of RB 19 dye. *c*0(RB 19) = 50 mg∙L-1, initial S2O82- concentration: a) before treatment, and after treatment with: b) 0.05, c) 0.1, d) 0.2, e) 0.4 and f) 0.6 mmol∙L-1, flow rate = 7 mL∙min-1, pH 3.0 ±0.1, UV light intensity = 1950 μW∙cm–2, temperature = 25 ± 0.5 º C



Figure 3**.** COD changes before and after UV/S2O82- treatment. *c*0(RB 19) = 50 mg∙L-1, *c*0(S2O82-) = 1 mmol∙L-1, flow rate = 1.5 mL∙min-1, pH 3 ± 0.1, UV light intensity = 1950 μW∙cm–2, temperature = 25 ± 0.5 ºC.



Figure 4. The influence of flow rateon RB 19 dye degradation (inset represents changes of *k* at different flow rates). *c*0(RB 19) = 50 mg∙L-1, *c*0(S2O82-) = 0.1 mmol∙L-1, native pH (3.8 ± 0.1) , UV light intensity = 1950 μW∙cm–2, temperature = 25 ± 0.5 ºC.



Figure 5.The influence of different initial RB 19 concentration on the its degradation (inset represents changes of *k* at different dye concentrations). *c*0(S2O82-) = 0.1 mmol∙L-1, flow rate = 7 mL∙min-1, pH native (3.8 ± 0.1), UV light intensity = 1950 μW∙cm–2, temperature = 25 ± 0.5 º C



Figure 6.The influence of different carbonate and bicarbonate anions concentrations on the removal efficiency of RB 19. *c*0(RB 19)= 50 mg∙L-1, *c*0(S2O82-) = 0.1 mmol∙L-1, flow rate = 7 mL∙min-1, pH 8.0±0.1 (for bicarbonate) 12±0.1 (for carbonate), UV light intensity = 1950 μW∙cm–2



Figure 7. The influence of different chloride anions concentrations on the removal efficiency of RB 19. *c*0(RB 19) = 50 mg∙L-1, *c*0(S2O82-) = 0.1 mmol∙L-1, flow rate = 7 mL∙min-1, pH native (3.8 ± 0.1), UV light intensity = 1950 μW∙cm–2

Example of *k* calculation according to equation 4:

Experimental conditions:

* initial pH value = 3.00 ±0.1
* initial S2O82- concentration = 0.1 mmol∙L-1
* flow rate = 7 mL∙min-1,
* UV light intensity = 1950 μW∙cm–2
* *c*0(RB 19) = 50 mg∙L-1 (before treatment)
* *c*(RB 19) = 1.64 mg∙L-1 (after treatment)
* τ = 22 min



*k* = 1/22min∙ln50/1.64 = 0.155 min-1

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