

*Supporting Materials*

# **Magnetite, Hematite and Zero-Valent Iron as Co-catalysts in Advanced Oxidation Processes Application for Cosmetic Wastewater Treatment**

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**Table 1.** Experimental setup.

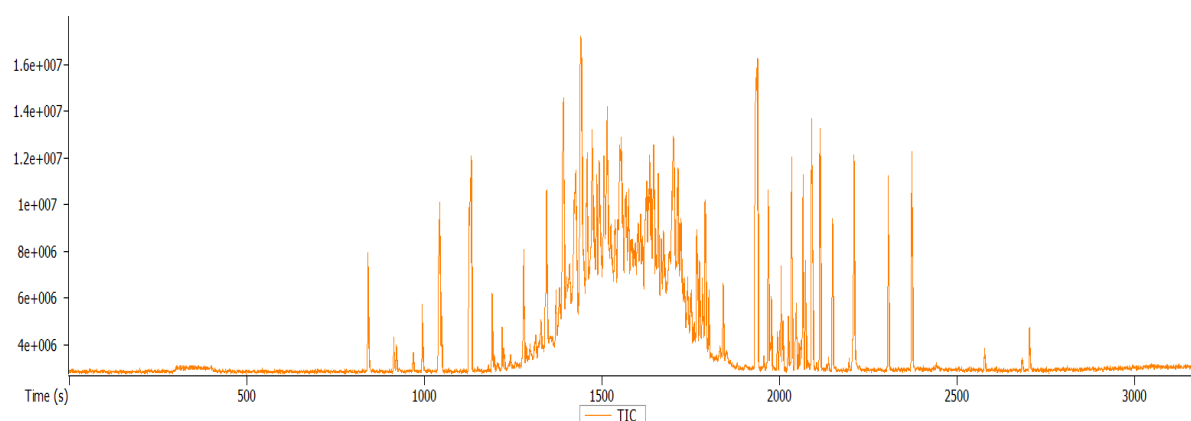
| No | Catalyst Dose (mg) |          |      | Total mass<br>(mg) | Calatyst Contribution (%) |          |      | H <sub>2</sub> O <sub>2</sub> /COD<br>Mass Ratio |
|----|--------------------|----------|------|--------------------|---------------------------|----------|------|--------------------------------------------------|
|    | Magnetite          | Hematite | Iron |                    | Magnetite                 | Hematite | Iron |                                                  |
| 1  | 500                | 500      | 3000 | 4000               | 12.5                      | 12.5     | 75   | 1:1                                              |
| 2  | 1000               | 1000     | 2000 | 4000               | 25                        | 25       | 50   | 1:1                                              |
| 3  | 1500               | 1500     | 1000 | 4000               | 37.5                      | 37.5     | 25   | 1:1                                              |
| 4  | 250                | 250      | 1500 | 2000               | 12.5                      | 12.5     | 75   | 1:1                                              |
| 5  | 500                | 500      | 1000 | 2000               | 25                        | 25       | 50   | 1:1                                              |
| 6  | 750                | 750      | 500  | 2000               | 37.5                      | 37.5     | 25   | 1:1                                              |
| 7  | 125                | 125      | 750  | 1000               | 12.5                      | 12.5     | 75   | 1:1                                              |
| 8  | 250                | 250      | 500  | 1000               | 25                        | 25       | 50   | 1:1                                              |
| 9  | 375                | 375      | 250  | 1000               | 37.5                      | 37.5     | 25   | 1:1                                              |
| 10 | 500                | 500      | 3000 | 4000               | 12.5                      | 12.5     | 75   | 2:1                                              |
| 11 | 1000               | 1000     | 2000 | 4000               | 25                        | 25       | 50   | 2:1                                              |
| 12 | 1500               | 1500     | 1000 | 4000               | 37.5                      | 37.5     | 25   | 2:1                                              |
| 13 | 250                | 250      | 1500 | 2000               | 12.5                      | 12.5     | 75   | 2:1                                              |
| 14 | 500                | 500      | 1000 | 2000               | 25                        | 25       | 50   | 2:1                                              |
| 15 | 750                | 750      | 500  | 2000               | 37.5                      | 37.5     | 25   | 2:1                                              |
| 16 | 125                | 125      | 750  | 1000               | 12.5                      | 12.5     | 75   | 2:1                                              |
| 17 | 250                | 250      | 500  | 1000               | 25                        | 25       | 50   | 2:1                                              |
| 18 | 375                | 375      | 250  | 1000               | 37.5                      | 37.5     | 25   | 2:1                                              |

**Table 2.** One-way analysis of variance for mean values of TOC for 1:1 H<sub>2</sub>O<sub>2</sub>/COD ratio.

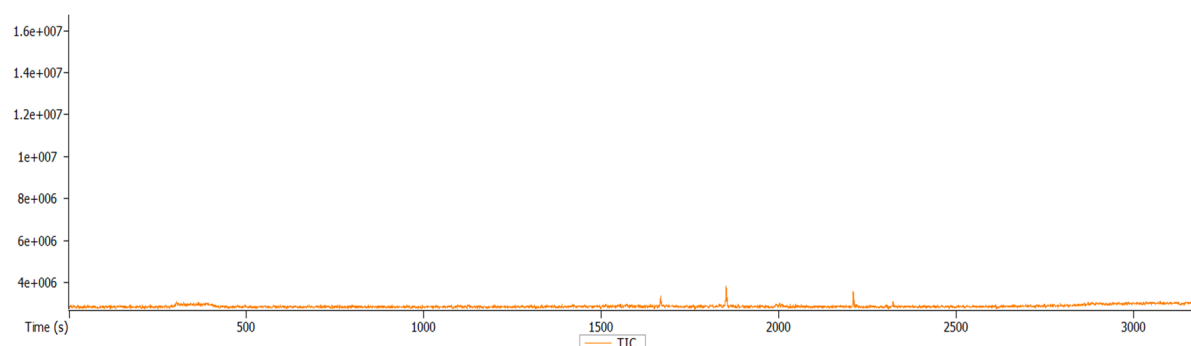
| Quantitative Proportions for Mag/Hem/Fe Catalysts (mg/L) | Counter  | Sum    | Mean    | Variance |         |        |
|----------------------------------------------------------|----------|--------|---------|----------|---------|--------|
| 500/500/3000                                             | 4        | 819.14 | 204.785 | 838.434  |         |        |
| 1000/1000/2000                                           | 4        | 857.64 | 214.409 | 334.154  |         |        |
| 1500/1500/1000                                           | 4        | 869.17 | 217.291 | 173.192  |         |        |
| 250/250/1500                                             | 4        | 888.07 | 222.018 | 254.832  |         |        |
| 500/500/1000                                             | 4        | 840.63 | 210.158 | 289.583  |         |        |
| 750/750/500                                              | 4        | 883.84 | 220.960 | 226.137  |         |        |
| 125/125/750                                              | 4        | 884.38 | 221.095 | 253.584  |         |        |
| 250/250/500                                              | 4        | 893.58 | 223.395 | 211.534  |         |        |
| 375/375/250                                              | 4        | 889.66 | 222.415 | 256.773  |         |        |
| Source of variance                                       | SS       | df     | MS      | F        | p-value | Test F |
| Between groups                                           | 1317.156 | 8      | 164.645 | 0.5221   | 0.8293  | 2.3053 |
| Within groups                                            | 8514.670 | 27     | 315.358 |          |         |        |
| Total                                                    | 9831.826 | 35     |         |          |         |        |

**Table 3.** One-way analysis of variance for mean values of TOC for 2:1 H<sub>2</sub>O<sub>2</sub>/COD ratio.

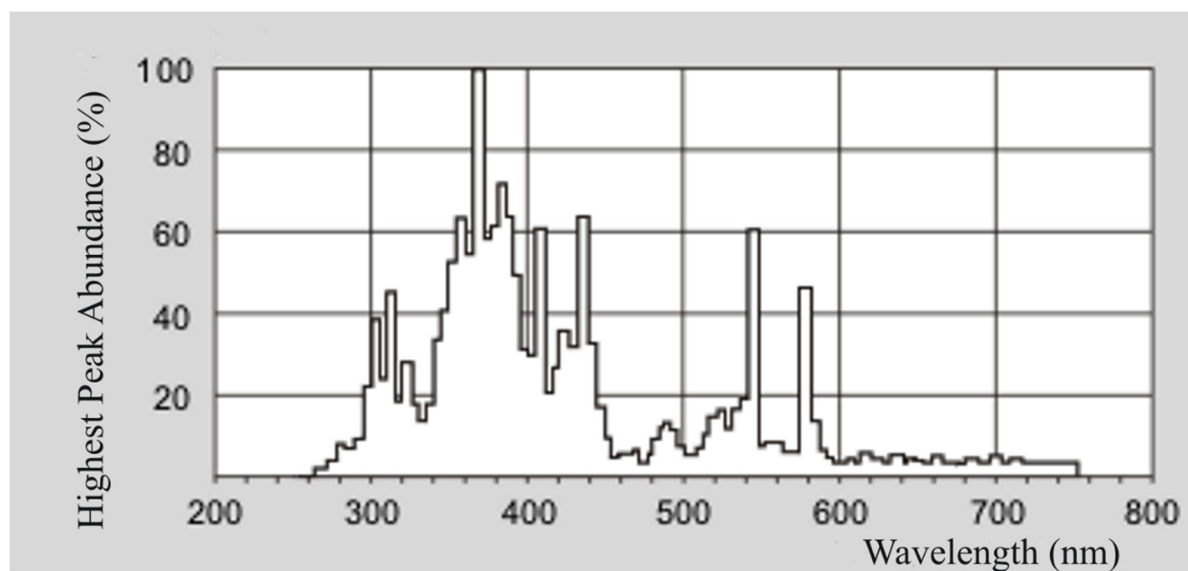
| Quantitative Proportions for Mag/Hem/Fe Catalysts (mg/L) | Counter  | Sum    | Mean    | Variance |         |        |
|----------------------------------------------------------|----------|--------|---------|----------|---------|--------|
| 500/500/3000                                             | 4        | 855.68 | 213.920 | 106.994  |         |        |
| 1000/1000/2000                                           | 4        | 860.71 | 215.178 | 234.481  |         |        |
| 1500/1500/1000                                           | 4        | 867.8  | 216.950 | 169.292  |         |        |
| 250/250/1500                                             | 4        | 877.59 | 219.396 | 475.543  |         |        |
| 500/500/1000                                             | 4        | 884.66 | 221.163 | 279.532  |         |        |
| 750/750/500                                              | 4        | 911.08 | 227.770 | 356.727  |         |        |
| 125/125/750                                              | 4        | 881.23 | 220.308 | 176.955  |         |        |
| 250/250/500                                              | 4        | 887.39 | 221.846 | 195.855  |         |        |
| 375/375/250                                              | 4        | 918.43 | 229.608 | 231.858  |         |        |
| Source of variance                                       | SS       | df     | MS      | F        | p-value | Test F |
| Between groups                                           | 892.949  | 8      | 111.619 | 0.4510   | 0.8790  | 2.3053 |
| Within groups                                            | 6681.708 | 27     | 247.471 |          |         |        |
| Total                                                    | 7574.657 | 35     |         |          |         |        |



**Figure 1.** Head space-solid phase micro extraction–gas chromatography–mass spectrometry (HS-SPME-GC-MS) chromatogram: Raw wastewater.



**Figure 2.** Head space-solid phase micro extraction–gas chromatography–mass spectrometry (HS-SPME-GC-MS) chromatogram: Treated wastewater, 500/500/1000 mg/L  $\text{Fe}_3\text{O}_4/\text{Fe}_2\text{O}_3/\text{Fe}^0$  catalyst doses, 1:1  $\text{H}_2\text{O}_2/\text{COD}$  ratio, pH=3.0, 120 min.



**Figure 3.** The emission spectrum of the lamp.

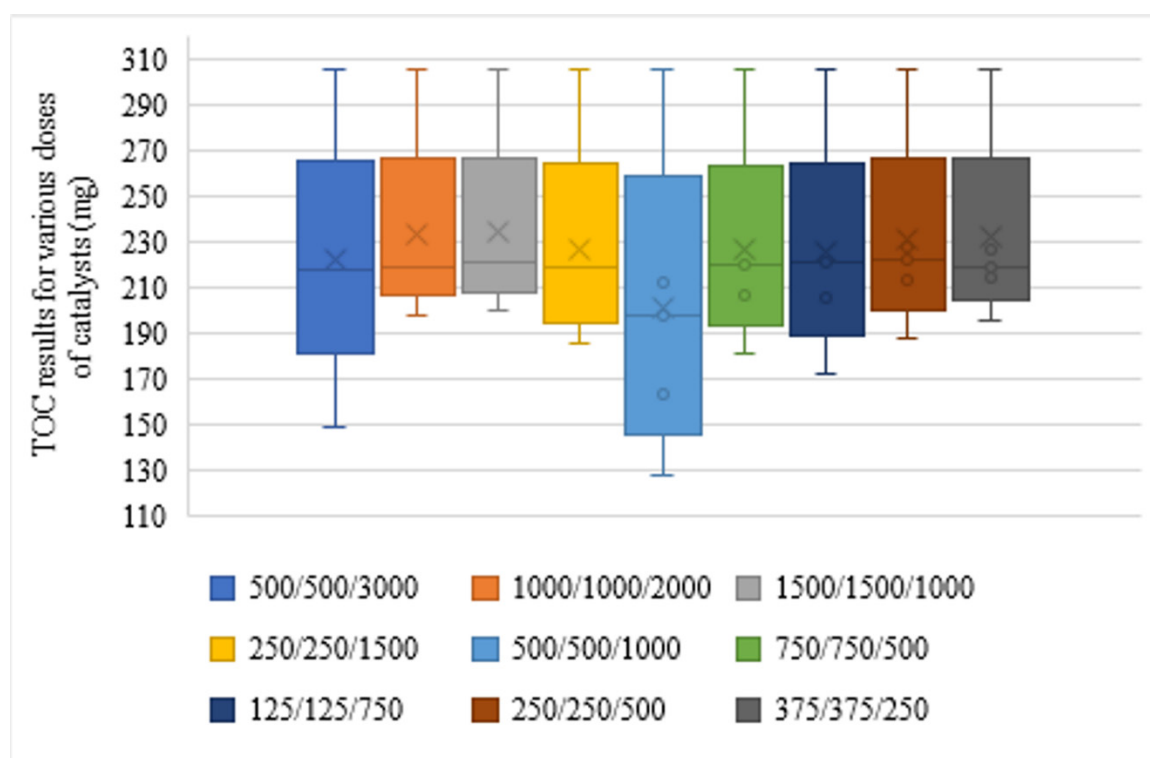


Figure 4. Anova plots UV/H<sub>2</sub>O<sub>2</sub>/Fe<sub>3</sub>O<sub>4</sub>/Fe<sub>2</sub>O<sub>3</sub>/Fe<sup>0</sup> process for different Magnetite/Hematite/Fe<sup>0</sup> doses (mg/L).

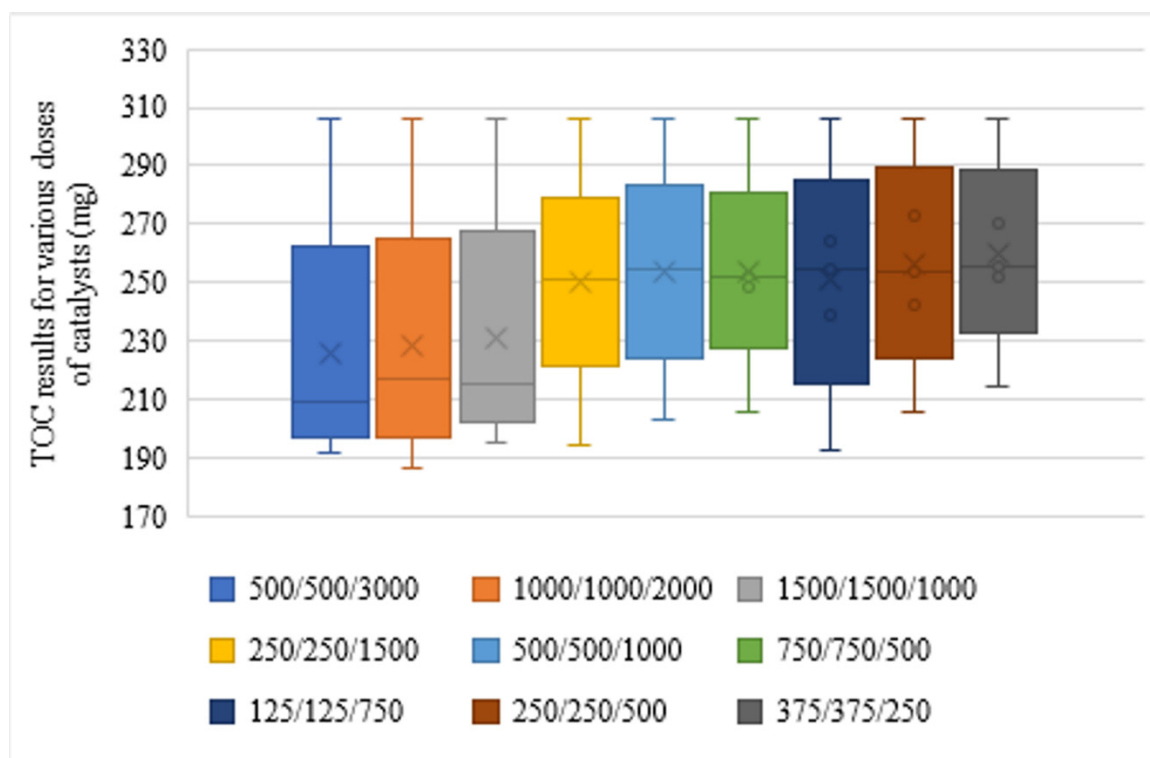


Figure 5. Anova plots H<sub>2</sub>O<sub>2</sub>/Fe<sub>3</sub>O<sub>4</sub>/Fe<sub>2</sub>O<sub>3</sub>/Fe<sup>0</sup> process for different Magnetite/Hematite/Fe<sup>0</sup> doses (mg/L).