**Sequential Optimization for Minimizing Material Cost and Treatment Time of Fenton Oxidation for Textile Wastewater Treatment**

Anam Asghar, Abdul Aziz Abdul Raman\*, Wan Mohd Ashri Wan Daud

1Postgraduate Student, Department of Chemical Engineering, Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia. Email: [chem.uet@hotmail.com](mailto:chem.uet@hotmail.com)

2Professor, Department of Chemical Engineering, Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia. (Corresponding Author). Email: [azizraman@um.edu.my](mailto:azizraman@um.edu.my)

3Professor, Department of Chemical Engineering, Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia. Email: ashri@um.edu.my

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**Central Composite Design**

Table S1 Experimental design matrix, experimental runs and predicted values on COD removal and Decolorization efficiency (Reprinted from Asghar et al., 2014).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Independent variables(X)** | | | | | **Dependent Variables (Y ;(%))** | | | |
|  | | | | | **Actual values** | | **Predicted Values** | |
| **Run** | **Dye**  **(mg/L)** | **H2O2:Fe+2**  **(wt/wt)** | **Dye:Fe+2**  **(wt/wt)** | **pH** | **COD  (%)** | **Decolorization  (%)** | **COD  (%)** | **Decolorization  (%)** |
| **1** | 200 | 15 | 30 | 5.5 | 75.3 | 95.4 | 73.2 | 95.1 |
| **2** | 200 | 15 | 30 | 5.5 | 76.4 | 95.4 | 73.2 | 95.1 |
| **3** | 300 | 25 | 50 | 9 | 62.8 | 96.8 | 60.9 | 95.7 |
| **4** | 200 | 25 | 30 | 5.5 | 73.4 | 98.1 | 69.8 | 97.5 |
| **5** | 300 | 5 | 50 | 9 | 34.8 | 80.0 | 35.1 | 79.8 |
| **6** | 200 | 15 | 30 | 5.5 | 73.4 | 95.5 | 73.2 | 95.1 |
| **7** | 100 | 5 | 10 | 9 | 66.5 | 55.8 | 63.4 | 59.7 |
| **8** | 100 | 25 | 50 | 2 | 87.7 | 99.2 | 85.3 | 100.0 |
| **9** | 200 | 15 | 30 | 9 | 65.8 | 78.9 | 67.3 | 80.3 |
| **10** | 300 | 15 | 30 | 5.5 | 78.3 | 94.5 | 80.2 | 98.6 |
| **11** | 100 | 15 | 30 | 5.5 | 77.1 | 90.1 | 73.9 | 86.7 |
| **12** | 100 | 5 | 10 | 2 | 67.0 | 93.4 | 66.1 | 92.2 |
| **13** | 100 | 5 | 50 | 9 | 30.2 | 56.1 | 32.9 | 54.4 |
| **14** | 200 | 15 | 30 | 5.5 | 74.5 | 95.4 | 73.2 | 95.1 |
| **15** | 300 | 5 | 10 | 9 | 77.9 | 89.1 | 79.4 | 85.9 |
| **16** | 200 | 5 | 30 | 5.5 | 60.8 | 84.3 | 63.3 | 85.6 |
| **17** | 100 | 25 | 10 | 9 | 48.0 | 67.9 | 50.51 | 65.1 |
| **18** | 200 | 15 | 30 | 5.5 | 70.3 | 94.6 | 73.20 | 95.1 |
| **19** | 300 | 25 | 10 | 2 | 67.4 | 98.9 | 63.6 | 98.3 |
| **20** | 300 | 5 | 10 | 2 | 61.4 | 95.2 | 62.5 | 95.6 |
| **21** | 100 | 25 | 10 | 2 | 50.3 | 97.6 | 53.1 | 99.9 |
| **22** | 200 | 15 | 10 | 5.5 | 67.7 | 98.2 | 67.7 | 97.7 |
| **23** | 300 | 25 | 10 | 9 | 80.4 | 84.4 | 80.5 | 86.3 |
| **24** | 300 | 25 | 50 | 2 | 75.5 | 99.4 | 81.8 | 97.7 |
| **25** | 200 | 15 | 30 | 2 | 74.1 | 98.3 | 79.1 | 97.5 |
| **26** | 100 | 25 | 50 | 9 | 44.7 | 73.6 | 44.9 | 75.4 |
| **27** | 200 | 15 | 50 | 5.5 | 62.7 | 93.5 | 61.6 | 94.7 |
| **28** | 200 | 15 | 30 | 5.5 | 73.4 | 96.6 | 73.2 | 95.1 |
| **29** | 100 | 5 | 50 | 2 | 72.1 | 76.5 | 73.4 | 76.7 |
| **30** | 300 | 5 | 50 | 2 | 61.2 | 78.9 | 55.9 | 79.4 |

Table S2 Optimized operating parameters (Reprinted from Asghar et al., 2014).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | | | Predicted responses | | |
| Dye  (mg/L) | **Dye: Fe+2**  **(wt/wt)** | **H2O2:Fe+2**  **(wt/wt)** | **pH** | **COD (%)** | **Decolorization (%)** | **Desirability** |
| 300 | 25.92 | 19.15 | 3 | 81.64 | 99.40 | 0.972 |

**Taguchi Method**

Table S3 L9 orthogonal design, Levels of four factors and experimental results obtained (Reproduced from main document of this paper)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Runs** | **Dye** | **Dye:Fe+2** | **H2O2:Fe+2** | **pH** | **COD** | **TOC** | **Decolorization** |
|  | **mg/L** | **wt/wt** | **wt/wt** |  | **(%)** | **(%)** | **(%)** |
| **1** | 1 | 1 | 1 | 1 | 77.01 | 63.17 | 98.86 |
| **2** | 1 | 2 | 2 | 2 | 35.63 | 30.16 | 96.67 |
| **3** | 1 | 3 | 3 | 3 | 16.09 | 9.93 | 96.96 |
| **4** | 2 | 1 | 2 | 3 | 14.29 | 5.48 | 91.42 |
| **5** | 2 | 2 | 3 | 1 | 80.13 | 72.86 | 96.99 |
| **6** | 2 | 3 | 1 | 2 | 46.75 | 46.75 | 96.25 |
| **7** | 3 | 1 | 3 | 2 | 30.60 | 41.44 | 99.31 |
| **8** | 3 | 2 | 1 | 3 | 7.65 | 12.35 | 93.12 |
| **9** | 3 | 3 | 2 | 1 | 66.56 | 59.02 | 99.60 |

Table S4 Fenton oxidation efficiency under optimized conditions

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameter | Dye | Dye:Fe+2 | H2O2: Fe+2 | pH | Predicted |
| COD | 200 | 50 | 25 | 3 | 76.29 |
| TOC | 300 | 50 | 5 | 3 | 66.297 |
| Decolorization | 100 | 50 | 25 | 3 | 98.51 |

\*Experiments on Taguchi were not performed. And Taguchi optimization technique was extended to do approximate cost estimations





Figure S1. Mean S/N ratio for **(a)** COD **(b)** TOC removal



Figure S2. Mean S/N ratio for decolorization

**References**

Asghar, A., Abdul Raman, A.A. and Daud, W. M. A. W. (2014). A Comparison of Central Composite Design and Taguchi Method for Optimizing Fenton Process. *Sci. World J.,* 2014(2014), 14.