**Supporting Information**

**Nutrient Recovery and Hydrogen Production from Wastewater by Electrodialysis Process: Optimization Using Response Surface Methodology**

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Appendix A Experimental sets created for RSM using Design Expert 12

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 |
| Run | A: membrane | B: voltage | C: Influent pH | D: Initial conductivity | E: Concentrate conductivity |
|  | Cell number | V |  | mS/cm | mS/cm |
| 1 | 12 | 5 | 8 | 27 | 2 |
| 2 | 8 | 5 | 8 | 27 | 4 |
| 3 | 10 | 7 | 7 | 36 | 3 |
| 4 | 8 | 5 | 8 | 45 | 4 |
| 5 | 10 | 7 | 7 | 36 | 3 |
| 6 | 8 | 9 | 8 | 27 | 2 |
| 7 | 12 | 9 | 8 | 45 | 4 |
| 8 | 8 | 9 | 6 | 45 | 2 |
| 9 | 10 | 11 | 7 | 36 | 3 |
| 10 | 10 | 7 | 9 | 36 | 3 |
| 11 | 6 | 7 | 7 | 36 | 3 |
| 12 | 8 | 5 | 6 | 45 | 2 |
| 13 | 10 | 7 | 7 | 36 | 1 |
| 14 | 8 | 5 | 6 | 45 | 4 |
| 15 | 8 | 5 | 6 | 27 | 2 |
| 16 | 8 | 9 | 6 | 27 | 4 |
| 17 | 12 | 9 | 6 | 45 | 2 |
| 18 | 10 | 7 | 7 | 36 | 3 |
| 19 | 10 | 7 | 7 | 36 | 5 |
| 20 | 12 | 9 | 6 | 45 | 4 |
| 21 | 12 | 5 | 6 | 27 | 2 |
| 22 | 8 | 9 | 6 | 45 | 4 |
| 23 | 8 | 5 | 8 | 45 | 2 |
| 24 | 12 | 5 | 6 | 45 | 4 |
| 25 | 10 | 3 | 7 | 36 | 3 |
| 26 | 10 | 7 | 5 | 36 | 3 |
| 27 | 8 | 5 | 6 | 27 | 4 |
| 28 | 12 | 9 | 8 | 27 | 2 |
| 29 | 8 | 9 | 8 | 45 | 2 |
| 30 | 10 | 7 | 7 | 36 | 3 |
| 31 | 12 | 9 | 8 | 27 | 4 |
| 32 | 12 | 9 | 6 | 27 | 2 |
| 33 | 14 | 7 | 7 | 36 | 3 |
| 34 | 10 | 7 | 7 | 36 | 3 |
| 35 | 12 | 5 | 8 | 27 | 4 |
| 36 | 8 | 9 | 6 | 27 | 2 |
| 37 | 10 | 7 | 7 | 18 | 3 |
| 38 | 8 | 5 | 8 | 27 | 2 |
| 39 | 12 | 9 | 6 | 27 | 4 |
| 40 | 12 | 5 | 8 | 45 | 4 |
| 41 | 8 | 9 | 8 | 45 | 4 |
| 42 | 10 | 7 | 7 | 36 | 3 |
| 43 | 10 | 7 | 7 | 36 | 3 |
| 44 | 12 | 5 | 6 | 45 | 2 |
| 45 | 10 | 7 | 7 | 54 | 3 |
| 46 | 12 | 5 | 6 | 27 | 4 |
| 47 | 10 | 7 | 7 | 36 | 3 |
| 48 | 12 | 5 | 8 | 45 | 2 |
| 49 | 8 | 9 | 8 | 27 | 4 |
| 50 | 12 | 9 | 8 | 45 | 2 |

APPENDİX B. ANOVA results for energy consumption, hydrogen production and treatment efficiency

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Energy Consumption** | | | | | | | |
| **Source** | **Sum of Squares** | **df** | | **Mean Square** | **F-value** | **p-value** |  |
| **Model** | 104.94 | 20 | | 5.25 | 27737.97 | <0.0001 | HS |
| A-membrane | 6.86 | 1 | | 6.86 | 36244.53 | <0.0001 | HS |
| B-voltage | 70.97 | 1 | | 70.97 | 3.752E+05 | <0.0001 | HS |
| C-Initial pH | 0.8585 | 1 | | 0.8585 | 4538.55 | <0.0001 | HS |
| D-Initial cond. | 6.58 | 1 | | 6.58 | 34771.50 | <0.0001 | HS |
| E-Concentrate cond. | 0.2434 | 1 | | 0.2434 | 1286.56 | <0.0001 | HS |
| AB | 1.22 | 1 | | 1.22 | 6432.81 | <0.0001 | HS |
| AC | 0.1830 | 1 | | 0.1830 | 967.53 | <0.0001 | HS |
| AD | 0.0420 | 1 | | 0.0420 | 222.30 | <0.0001 | HS |
| AE | 0.1152 | 1 | | 0.1152 | 609.02 | <0.0001 | HS |
| BC | 0.0024 | 1 | | 0.0024 | 12.95 | 0.0012 | S |
| BD | 2.19 | 1 | | 2.19 | 11601.65 | <0.0001 | HS |
| BE | 0.0001 | 1 | | 0.0001 | 0.5947 | 0.4468 | NS |
| CD | 0.3784 | 1 | | 0.3784 | 2000.74 | <0.0001 | HS |
| CE | 0.1860 | 1 | | 0.1860 | 983.58 | <0.0001 | HS |
| DE | 0.3655 | 1 | | 0.3655 | 1932.34 | <0.0001 | HS |
| A² | 4.16 | 1 | | 4.16 | 21970.56 | <0.0001 | HS |
| B² | 7.19 | 1 | | 7.19 | 38029.22 | <0.0001 | HS |
| C² | 0.4734 | 1 | | 0.4734 | 2502.52 | <0.0001 | HS |
| D² | 2.47 | 1 | | 2.47 | 13062.63 | <0.0001 | HS |
| E² | 0.4541 | 1 | | 0.4541 | 2400.70 | <0.0001 | HS |
| **Residual** | 0.0055 | 29 | | 0.0002 |  |  |  |
| Lack of Fit | 0.0049 | 22 | | 0.0002 | 2.86 | 0.0789 | NS |
| Pure Error | 0.0006 | 7 | | 0.0001 |  |  |  |
| **Cor Total** | 104.94 | 49 | |  |  |  |  |
| **Hydrogen Production** | | | | | | | |
| **Source** | **Sum of Squares** | **df** | | **Mean Square** | **F-value** | **p-value** |  |
| **Model** | 1.738E+05 | 20 | 8690.14 | | 14004.67 | <0.0001 | HS |
| A-membrane | 34928.10 | 1 | 34928.10 | | 56288.69 | <0.0001 | HS |
| B-voltage | 1.080E+05 | 1 | 1.080E+05 | | 1.740E+05 | <0.0001 | HS |
| C-Initial pH | 2.50 | 1 | 2.50 | | 4.03 | 0.0541 | NS |
| D-Initial cond | 22848.40 | 1 | 22848.40 | | 36821.54 | <0.0001 | HS |
| E-Concentrate cond. | 62.50 | 1 | 62.50 | | 100.72 | <0.0001 | HS |
| AB | 325.13 | 1 | 325.13 | | 523.96 | <0.0001 | HS |
| AC | 60.50 | 1 | 60.50 | | 97.50 | <0.0001 | HS |
| AD | 6.13 | 1 | 6.13 | | 9.87 | 0.0038 | S |
| AE | 18.00 | 1 | 18.00 | | 29.01 | <0.0001 | HS |
| BC | 98.00 | 1 | 98.00 | | 157.93 | <0.0001 | HS |
| BD | 5565.13 | 1 | 5565.13 | | 8968.53 | <0.0001 | HS |
| BE | 8.00 | 1 | 8.00 | | 12.89 | 0.0012 | S |
| CD | 4.50 | 1 | 4.50 | | 7.25 | 0.0116 | S |
| CE | 6.13 | 1 | 6.13 | | 9.87 | 0.0038 | S |
| DE | 2.00 | 1 | 2.00 | | 3.22 | 0.0830 | NS |
| A² | 1806.01 | 1 | 1806.01 | | 2910.48 | <0.0001 | HS |
| B² | 18.61 | 1 | 18.61 | | 29.98 | <0.0001 | HS |
| C² | 61.61 | 1 | 61.61 | | 99.28 | <0.0001 | HS |
| D² | 4.21 | 1 | 4.21 | | 6.78 | 0.0144 | S |
| E² | 25.21 | 1 | 25.21 | | 40.62 | <0.0001 | HS |
| **Residual** | 17.99 | 29 | 0.6205 | |  |  |  |
| Lack of Fit | 10.49 | 22 | 0.4770 | | 0.4452 | 0.9305 | NS |
| Pure Error | 7.50 | 7 | 1.07 | |  |  |  |
| **Cor Total** | 1.738E+05 | 49 |  | |  |  |  |
| **Nutrient Recovery** | | | | | | | |
| **Source** | **Sum of Squares** | **df** | **Mean Square** | | **F-value** | **p-value** |  |
| **Model** | 22784.75 | 20 | 1139.24 | | 1113.51 | <0.0001 | HS |
| A-membrane | 324.90 | 1 | 324.90 | | 317.56 | <0.0001 | HS |
| B-voltage | 15054.40 | 1 | 15054.40 | | 14714.45 | <0.0001 | HS |
| C-Initial pH | 3.60 | 1 | 3.60 | | 3.52 | 0.0708 | NS |
| D-Initial cond | 2402.50 | 1 | 2402.50 | | 2348.25 | <0.0001 | HS |
| E-Concentrate cond. | 67.60 | 1 | 67.60 | | 66.07 | <0.0001 | HS |
| AB | 1.13 | 1 | 1.13 | | 1.10 | 0.3030 | NS |
| AC | 0.1250 | 1 | 0.1250 | | 0.1222 | 0.7292 | NS |
| AD | 28.13 | 1 | 28.13 | | 27.49 | <0.0001 | HS |
| AE | 12.50 | 1 | 12.50 | | 12.22 | 0.0015 | S |
| BC | 0.5000 | 1 | 0.5000 | | 0.4887 | 0.4901 | NS |
| BD | 128.00 | 1 | 128.00 | | 125.11 | <0.0001 | HS |
| BE | 36.13 | 1 | 36.13 | | 35.31 | <0.0001 | HS |
| CD | 4.50 | 1 | 4.50 | | 4.40 | 0.0448 | S |
| CE | 0.1250 | 1 | 0.1250 | | 0.1222 | 0.7292 | NS |
| DE | 1.13 | 1 | 1.13 | | 1.10 | 0.3030 | NS |
| A² | 1280.18 | 1 | 1280.18 | | 1251.27 | <0.0001 | HS |
| B² | 1601.78 | 1 | 1601.78 | | 1565.61 | <0.0001 | HS |
| C² | 21.78 | 1 | 21.78 | | 21.29 | <0.0001 | HS |
| D² | 865.28 | 1 | 865.28 | | 845.74 | <0.0001 | HS |
| E² | 950.48 | 1 | 950.48 | | 929.02 | <0.0001 | HS |
| **Residual** | 29.67 | 29 | 1.02 | |  |  |  |
| Lack of Fit | 25.79 | 22 | 1.17 | | 2.12 | 0.1558 | NS |
| Pure Error | 3.88 | 7 | 0.5536 | |  |  |  |
| **Cor Total** | 22814.42 | 49 |  | |  |  |  |

**\*HS: Highly significant S= Significant NS: Not significant**