**Supplementary data**

Table S1. ANOVA results of the regression model for zinc, copper and iron recovery with three factors and two levels

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| %Ex. Zn | SS | Df | MS | F | p | 95% Significance |
| (1)pH | 496.19 | 1 | 496.19 | 404.60 | <0.0001 | Significant |
| (2)P.D. (%) | 68.84 | 1 | 68.84 | 56.14 | <0.0001 | Significant |
| (3)T (°C) | 4.50 | 1 | 4.50 | 3.67 | 0.0818 | Non-significant |
| 1 by 2 | 34.68 | 1 | 34.68 | 28.28 | 0.0002 | Significant |
| 1 by 3 | 1.14 | 1 | 1.14 | 0.93 | 0.3565 | Non-significant |
| 2 by 3 | 0.03 | 1 | 0.03 | 0.03 | 0.8692 | Non-significant |
| Error | 13.49 | 11 | 1.23 |  |  | Non-significant |
| Total SS | 739.99 | 17 |  |  |  | Non-significant |
| R2 | 0.9818 |  |  |  |  |  |
| Adjusted R2 | 0.9718 | Deviation between R2 and R2adj | | | | 1.0125 |
| %Ex. Cu | SS | Df | MS | F | p | 95%Significance |
| (1)pH | 1326.76 | 1 | 1326.76 | 224.85 | <0.0001 | Significant |
| (2)P.D. (%) | 17.87 | 1 | 17.87 | 3.03 | 0.1097 | Non-significant |
| (3)T (°C) | 21.09 | 1 | 21.09 | 3.57 | 0.0853 | Non-significant |
| 1 by 2 | 19.40 | 1 | 19.40 | 3.29 | 0.0972 | Non-significant |
| 1 by 3 | 8.17 | 1 | 8.17 | 1.38 | 0.2642 | Non-significant |
| 2 by 3 | 9.25 | 1 | 9.25 | 1.57 | 0.2366 | Non-significant |
| Error | 64.91 | 11 | 5.90 |  |  | Non-significant |
| Total SS | 1596.85 | 17 |  |  |  | Non-significant |
| R2 | 0.9594 |  |  |  |  |  |
| Adjusted R2 | 0.9372 | Deviation between R2 and R2adj | | | | 2.3109 |
| %Ex. Fe | SS | Df | MS | F | p | 95% Significance |
| (1)pH | 7792.00 | 1 | 7792.00 | 651.33 | <0.0001 | Significant |
| (2)P.D. (%) | 18.28 | 1 | 18.28 | 1.53 | 0.2421 | Non-significant |
| (3)T (°C) | 0.19 | 1 | 0.19 | 0.02 | 0.9024 | Non-significant |
| 1 by 2 | 65.17 | 1 | 65.17 | 5.45 | 0.0396 | Significant |
| 1 by 3 | 34.99 | 1 | 34.99 | 2.92 | 0.1153 | Non-significant |
| 2 by 3 | 59.98 | 1 | 59.98 | 5.01 | 0.0468 | Significant |
| Error | 131.60 | 11 | 11.96 |  |  | Non-significant |
| Total SS | 8650.13 | 17 |  |  |  | Non-significant |
| R2 | 0.9848 |  |  |  |  |  |
| Adjusted R2 | 0.9765 | Deviation between R2 and R2adj | | | | 0.8428 |
| SS: Sum of squares; df: Degree of freedom; MS: Mean sum | | | | | | |

Table S2. ANOVA results of regression model for zinc, copper and iron recovery with two factors and three levels

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| %Ex. Zn | SS | Df | | MS | | F | | P | | 98% Significance |
| (1) pH (L) | 351.92 | 1 | | 351.92 | | 303.60 | | <0.0001 | | Significant |
| pH (Q) | 11.09 | 1 | | 11.09 | | 9.57 | | 0.0060 | | Significant |
| (2)P.D. (%) ( L) | 84.67 | 1 | | 84.67 | | 73.04 | | <0.0001 | | Significant |
| P.D. (%) (Q) | 36.23 | 1 | | 36.23 | | 31.25 | | <0.0001 | | Significant |
| 1L by 2L | 38.37 | 1 | | 38.37 | | 33.10 | | <0.0001 | | Significant |
| 1L by 2Q | 33.57 | 1 | | 33.57 | | 28.96 | | <0.0001 | | Significant |
| 1Q by 2L | 0.09 | 1 | | 0.09 | | 0.08 | | 0.7789 | | Non-significant |
| 1Q by 2Q | 1.54 | 1 | | 1.54 | | 1.33 | | 0.2631 | | Non-significant |
| Error | 22.02 | 19 | | 1.16 | |  | |  | |  |
| Total SS | 916.30 | 27 | |  | |  | |  | |  |
| R2 | 0.9760 |  | |  | |  | |  | |  |
| Adjusted R2 | 0.9658 | | Deviation between R2 and R2adj | | | | | | | 1.0369 |
| %Ex. Cu | SS | Df | | MS | | F | | P | | 98% Significance |
| (1)pH (L) | 1147.23 | 1 | | 1147.23 | | 214.93 | | <0.0001 | | Significant |
| pH (Q) | 13.08 | 1 | | 13.08 | | 2.45 | | 0.1339 | | Non-significant |
| (2)P.D. (%) (L) | 13.91 | 1 | | 13.91 | | 2.61 | | 0.1230 | | Non-significant |
| P.D. (%) (Q) | 46.62 | 1 | | 46.62 | | 8.73 | | 0.0081 | | Significant |
| 1L by 2L | 20.74 | 1 | | 20.74 | | 3.89 | | 0.0634 | | Non-significant |
| 1L by 2Q | 25.63 | 1 | | 25.63 | | 4.80 | | 0.0411 | | Significant |
| 1Q by 2L | 1.00 | 1 | | 1.00 | | 0.19 | | 0.6707 | | Non-significant |
| 1Q by 2Q | 1.46 | 1 | | 1.46 | | 0.27 | | 0.6075 | | Non-significant |
| Error | 101.42 | 19 | | 5.34 | |  | |  | |  |
| Total SS | 1974.63 | 27 | |  | |  | |  | |  |
| R2 | 0.9486 |  | |  | |  | |  | |  |
| Adjusted R2 | 0.9270 | | Deviation between R2 and R2adj | | | | | | | 2.2791 |
| %Ex. Fe | SS | Df | | | MS | | F | | P | 98% Significance |
| (1)pH (L) | 8491.99 | 1 | | 8491.99 | | 711.96 | | <0.0001 | | Significant |
| pH (Q) | 0.01 | 1 | | 0.01 | | 0.00 | | 0.9730 | | Non-significant |
| (2)P.D. (%) (L) | 6.30 | 1 | | 6.30 | | 0.53 | | 0.4762 | | Non-significant |
| P.D. (%) (Q) | 0.01 | 1 | | 0.01 | | 0.00 | | 0.9822 | | Non-significant |
| 1L by 2L | 68.28 | 1 | | 68.28 | | 5.72 | | 0.0272 | | Significant |
| 1L by 2Q | 0.35 | 1 | | 0.35 | | 0.03 | | 0.8660 | | Non-significant |
| 1Q by 2L | 6.59 | 1 | | 6.59 | | 0.55 | | 0.4663 | | Non-significant |
| 1Q by 2Q | 2.68 | 1 | | 2.68 | | 0.22 | | 0.6409 | | Non-significant |
| Error | 226.63 | 19 | | 11.93 | |  | |  | |  |
| Total SS | 11063.22 | 27 | |  | |  | |  | |  |
| R2 | 0.9795 |  | |  | |  | |  | |  |
| Adjusted R2 | 0.9708 | | Deviation between R2 and R2adj | | | | | | | 0.8902 |
| SS: Sum of squares; df: Degree of freedom; MS: Mean sum; L: Linear; Q: Quadratic | | | | | | | | | | |