*Original Research Article*

**Modell-Based Assessment of Heavy Metals Leaching Behaviour in Wasted Activated Sludge Utilization**

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## Supplementary Data

Table 1. Predicted Compounds in pH-Independent Metal Leaching Behavior from WAS Modeling Using Visual MINTEQ

| **Predicted Compound** | **Concentration (mol/L)** |
| --- | --- |
| Al(OH)2+ | 6.7491E-07 |
| Al(OH)3 (aq) | 5.9162E-10 |
| Al(OH)4- | 1.0619E-12 |
| Al+3 | 0.011066 |
| Al2(OH)2+4 | 0.000012329 |
| Al2PO4+3 | 0.0016231 |
| Al3(OH)4+5 | 6.9789E-07 |
| AlHPO4+ | 0.00070407 |
| AlOH+2 | 0.000096309 |
| AsO4-3 | 2.8915E-18 |
| Ba+2 | 0.000020387 |
| BaHPO4 (aq) | 1.2477E-11 |
| BaOH+ | 1.2443E-15 |
| Ca+2 | 0.0065953 |
| CaH2PO4+ | 3.9712E-06 |
| CaHPO4 (aq) | 1.1246E-08 |
| CaOH+ | 1.84E-12 |
| CaPO4- | 1.0947E-13 |
| Cd(OH)2 (aq) | 2.8348E-21 |
| Cd(OH)3- | 1.0223E-30 |
| Cd(OH)4-2 | 6.0515E-41 |
| Cd+2 | 1.8372E-07 |
| Cd2OH+3 | 4.8493E-20 |
| CdHPO4 (aq) | 3.4745E-12 |
| CdOH+ | 2.0404E-14 |
| Co+3 | 6.4345E-08 |
| CoOH+2 | 2.8457E-06 |
| Cr(OH)2+1 | 1.099E-09 |
| Cr(OH)3 (aq) | 1.0735E-12 |
| Cr(OH)4- | 1.361E-20 |
| Cr+3 | 6.3348E-06 |
| Cr2(OH)2+4 | 1.9972E-09 |
| Cr3(OH)4+5 | 1.799E-13 |
| CrH2PO4+2 | 3.3061E-08 |
| CrHPO4+ | 6.5367E-11 |
| CrOH+2 | 1.4737E-06 |
| Cu(OH)2 (aq) | 7.1322E-15 |
| Cu(OH)3- | 1.0146E-21 |
| Cu(OH)4-2 | 4.7486E-31 |
| Cu+2 | 0.000039889 |
| Cu2(OH)2+2 | 1.5804E-13 |
| Cu2OH+3 | 1.1119E-12 |
| Cu3(OH)4+2 | 9.9234E-22 |
| CuHPO4 (aq) | 1.9842E-09 |
| CuOH+ | 1.7637E-09 |
| Fe(OH)2+ | 0.00043426 |
| Fe(OH)3 (aq) | 5.3401E-10 |
| Fe(OH)4- | 3.8959E-14 |
| Fe+3 | 0.00020347 |
| Fe2(OH)2+4 | 0.00026299 |
| Fe3(OH)4+5 | 0.0001727 |
| FeH2PO4+2 | 0.000064458 |
| FeHPO4+ | 0.0024385 |
| FeOH+2 | 0.0016795 |
| H+1 | 0.00044798 |
| H2AsO4- | 3.3429E-07 |
| H2PO4- | 0.00006942 |
| H3AsO4 | 1.8231E-08 |
| H3PO4 | 2.6678E-06 |
| HAsO4-2 | 1.9709E-10 |
| Hg(OH)2 | 4.432E-10 |
| Hg+2 | 2.1292E-10 |
| Hg2OH+3 | 8.2003E-20 |
| Hg3(OH)3+3 | 4.3563E-26 |
| HgOH+ | 1.1852E-10 |
| HPO4-2 | 2.5353E-08 |
| K+1 | 0.00045262 |
| K2HPO4 (aq) | 1.6373E-14 |
| K2PO4- | 3.4471E-22 |
| KH2PO4 (aq) | 3.8251E-08 |
| KHPO4- | 3.3726E-11 |
| KOH (aq) | 1.732E-14 |
| KPO4-2 | 2.9075E-19 |
| Mg+2 | 0.0014561 |
| MgHPO4 (aq) | 3.4271E-09 |
| MgOH+ | 7.7403E-12 |
| MgPO4- | 3.7779E-16 |
| Mn(OH)4-2 | 2.3113E-38 |
| Mn+2 | 0.00070169 |
| Mn2(OH)3+ | 2.7223E-21 |
| Mn2OH+3 | 4.4635E-14 |
| MnHPO4 (aq) | 6.9646E-09 |
| MnOH+ | 2.4645E-11 |
| Na+1 | 0.00039362 |
| Na2HPO4 (aq) | 8.1809E-15 |
| Na2PO4- | 5.5735E-22 |
| NaH2PO4 (aq) | 3.3264E-08 |
| NaHPO4- | 4.5426E-11 |
| NaOH (aq) | 1.0911E-14 |
| NaPO4-2 | 2.5284E-19 |
| Ni(OH)2 (aq) | 1.8691E-18 |
| Ni(OH)3- | 6.8815E-26 |
| Ni+2 | 6.0708E-06 |
| NiH2PO4+ | 1.3802E-09 |
| NiHPO4 (aq) | 2.0417E-11 |
| NiOH+ | 1.0686E-12 |
| OH- | 3.6089E-11 |
| Pb(OH)2 (aq) | 8.314E-17 |
| Pb(OH)3- | 3.0611E-24 |
| Pb+2 | 3.3996E-06 |
| Pb2OH+3 | 1.6605E-14 |
| Pb3(OH)4+2 | 4.88E-28 |
| Pb4(OH)4+4 | 1.1052E-29 |
| PbH2PO4+ | 2.8915E-09 |
| PbHPO4 (aq) | 1.5965E-11 |
| PbOH+ | 1.194E-10 |
| PO4-3 | 9.8964E-17 |
| Sn(OH)2 | 2.1848E-07 |
| Sn(OH)3- | 2.5437E-13 |
| Sn+2 | 8.9338E-07 |
| Sn2(OH)2+2 | 3.9731E-11 |
| Sn3(OH)4+2 | 9.273E-13 |
| SnOH+ | 4.9729E-07 |
| U(HPO4)2 (aq) | 7.3197E-10 |
| U(HPO4)3-2 | 4.2974E-09 |
| U(HPO4)4-4 | 0.000000254 |
| U(OH)2+2 | 1.048E-09 |
| U(OH)3+ | 3.6555E-10 |
| U(OH)4 (aq) | 4.0064E-12 |
| U+4 | 2.8374E-14 |
| UHPO4+2 | 1.8956E-11 |
| UOH+3 | 4.4025E-12 |
| Zn(OH)2 (aq) | 1.1088E-14 |
| Zn(OH)3- | 1.2909E-22 |
| Zn(OH)4-2 | 1.1863E-31 |
| Zn+2 | 0.00028606 |
| Zn2OH+3 | 2.9532E-13 |
| ZnHPO4 (aq) | 2.204E-09 |
| ZnOH+ | 3.9998E-10 |

Table 2. Saturation Index Calculations in pH-Independent Metal Leaching Behavior from WAS Modeling Using Visual MINTEQ

| **Mineral** | **log IAP** | **Sat. index** |
| --- | --- | --- |
| Al(OH)3 (am) | 7.469 | -3.331 |
| Al(OH)3 (Soil) | 7.469 | -0.821 |
| Al2O3(s) | 14.941 | -4.711 |
| AlAsO4:2H2O(s) | -21.351 | -5.551 |
| AlPO4x1.5H2O | -19.816 | 0.644 |
| As2O5(s) | -57.637 | -22.947 |
| Ba(OH)2:8H2O(s) | 1.788 | -22.606 |
| Ba3(AsO4)3(c) | -52.238 | -28.708 |
| BaHAsO4:H2O(s) | -27.021 | -9.621 |
| BaHPO4(s) | -25.485 | -5.71 |
| Boehmite | 7.47 | -1.108 |
| Brucite | 3.652 | -13.448 |
| Ca3(AsO4)2:4H2O(s) | -44.714 | -25.814 |
| Ca3(PO4)2 (am1) | -41.64 | -16.14 |
| Ca3(PO4)2 (am2) | -41.64 | -13.39 |
| Ca3(PO4)2 (beta) | -41.64 | -12.72 |
| Ca4H(PO4)3:3H2O(s) | -64.619 | -16.669 |
| CaHPO4(s) | -22.975 | -3.7 |
| CaHPO4:2H2O(s) | -22.978 | -3.983 |
| Cd(OH)2(s) | -0.247 | -13.891 |
| Cd3(PO4)2(s) | -55.305 | -22.705 |
| Co(OH)3(s) | 2.233 | 4.542 |
| Cr(OH)3 (am) | -5.612 | -5.122 |
| Cr2O3 (c) | -11.219 | -9.899 |
| Cu(OH)2(s) | 2.09 | -7.2 |
| Cu3(AsO4)2:2H2O(s) | -51.366 | -16.266 |
| Cu3(PO4)2(s) | -48.295 | -11.445 |
| Cu3(PO4)2:3H2O(s) | -48.299 | -13.179 |
| Cupric Ferrite | 13.561 | 7.573 |
| Diaspore | 7.47 | 0.597 |
| FeAsO4:2H2O(s) | -23.086 | -2.886 |
| Ferrihydrite | 5.733 | 2.533 |
| Ferrihydrite (aged) | 5.733 | 3.043 |
| Gibbsite (C) | 7.469 | -0.271 |
| Goethite | 5.734 | 5.243 |
| Hematite | 11.47 | 12.888 |
| Hg(OH)2(s) | -9.345 | -5.848 |
| Hydroxyapatite | -60.306 | -15.973 |
| Hydroxylpyromorphite | -76.745 | -13.955 |
| Lepidocrocite | 5.734 | 4.363 |
| Lime | 4.31 | -28.39 |
| Litharge | 1.022 | -11.668 |
| Maghemite | 11.47 | 5.084 |
| Magnesioferrite | 15.124 | -1.736 |
| Massicot | 1.022 | -11.868 |
| Mg(OH)2 (active) | 3.652 | -15.142 |
| Mg3(PO4)2(s) | -43.608 | -20.328 |
| MgCr2O4(s) | -7.566 | -23.766 |
| MgHPO4:3H2O(s) | -23.635 | -5.46 |
| Mn3(AsO4)2:8H2O(s) | -47.638 | -18.938 |
| Mn3(PO4)2(s) | -44.559 | -20.732 |
| MnHPO4(s) | -23.948 | 1.452 |
| Montroydite | -9.343 | -5.733 |
| Ni(OH)2 (am) | 1.272 | -11.618 |
| Ni(OH)2 (c) | 1.272 | -9.518 |
| Ni3(AsO4)2:8H2O(s) | -53.827 | -28.327 |
| Ni3(PO4)2(s) | -50.748 | -19.448 |
| Ningyoite | -51.652 | 2.254 |
| Pb(OH)2(s) | 1.02 | -7.13 |
| Pb2O(OH)2(s) | 2.042 | -24.148 |
| Pb3(AsO4)2(s) | -54.572 | -19.072 |
| Pb3(PO4)2(s) | -51.503 | -7.973 |
| PbHPO4(s) | -26.263 | -2.458 |
| PbO:0.3H2O(s) | 1.021 | -11.959 |
| Periclase | 3.653 | -17.931 |
| Plumbgummite | -31.139 | 1.651 |
| Portlandite | 4.308 | -18.396 |
| Pyrochroite | 3.335 | -11.859 |
| Sn(OH)2(s) | -6.652 | -1.752 |
| SnO(s) | -6.651 | -1.351 |
| Spinel | 18.595 | -18.253 |
| Strengite | -21.552 | 4.848 |
| Tenorite(am) | 2.091 | -6.399 |
| Tenorite(c) | 2.091 | -5.549 |
| Tsumebite | -23.155 | -13.365 |
| U(HPO4)2:4H2O(s) | -55.965 | -0.755 |
| UO2 (am) | -1.39 | -2.89 |
| Uraninite | -1.39 | 3.46 |
| Variscite | -19.816 | 2.254 |
| Zincite | 2.947 | -8.283 |
| Zn(OH)2 (am) | 2.945 | -9.529 |
| Zn(OH)2 (beta) | 2.945 | -8.809 |
| Zn(OH)2 (delta) | 2.945 | -8.899 |
| Zn(OH)2 (epsilon) | 2.945 | -8.589 |
| Zn(OH)2 (gamma) | 2.945 | -8.789 |
| Zn3(PO4)2:4H2O(s) | -45.733 | -10.313 |
| Zn3AsO42:2.5H2O(s) | -48.8 | -21.3 |
| ZnHAsO4:H2O(s) | -25.874 | -3.974 |