Table 4. The best obtained results for Quaternary systems using **GA** and **PSO**.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **System** | **Model** |  | **GA** | | **PSO** | |  | |
|  |  |  |  | GA | PSO |
| Ethanol (**1**)  Water (**2**)  Pentane (**3**)  Hexane (**4**) | Wilson | 1-2 | 129.36 | 367.19 | 133.33 | 359.06 | 5.69 | 6.38 |
| 1-3 | -812.37 | 503.22 | -789.66 | 500.30 |
| 1-4 | 1205.27 | 66.03 | 1000.01 | 100.06 |
| 2-3 | -101.05 | -781.59 | -99.99 | -801.56 |
| 2-4 | 1399.81 | -16.01 | 1450.30 | -50.36 |
| 3-4 | 351 | -266.73 | 366.07 | -246.38 |
|  | | | | | | | |
| UNIQUAC | 1-2 | 10.86 | 536.30 | 12.03 | 520.36 | 1.002 | 1.001 |
| 1-3 | -249.64 | 1248.46 | -255.55 | 1200.01 |
| 1-4 | -6.55 | 528.85 | -10.00 | 500.03 |
| 2-3 | 1773.48 | 502.86 | 1730.50 | 490.85 |
| 2-4 | 757.84 | 1356.49 | 750.50 | 1500.06 |
| 3-4 | 280.07 | -323.94 | 301.07 | -350.03 |
|  | | | | | | | |
| NRTL | 1-2 | 12.97 | 209.77 | 15.06 | 200.02 | 1.021 | 1.031 |
| 1-3 | -124.65 | 575.16 | -163.33 | 570.00 |
| 1-4 | -39.09 | 830.10 | -29.35 | 800.21 |
| 2-3 | 1273.42 | 1092.89 | 1208.15 | 998.08 |
| 2-4 | 342.33 | 1640.57 | 421.81 | 1708.28 |
| 3-4 | 364.24 | -284.34 | 402.02 | -316.99 |
|  |  | | | | | | | |
| Ethanol (**1**)  Water (**2**)  Pentane (**3**)  Cyclohexane (**4**) | Wilson | 1-2 | -700.71 | -232.17 | -680.07 | -307.82 | 7.09 | 6.99 |
| 1-3 | 1126.99 | 576.68 | 1002.20 | 610.29 |
| 1-4 | 286.54 | 864.76 | 300.01 | 790.88 |
| 2-3 | 50.59 | 645.47 | 70.06 | 702.36 |
| 2-4 | 712.49 | 102.51 | 720.09 | 100.30 |
| 3-4 | 218.35 | -172.65 | 200.62 | -200.02 |
|  | | | | | | | |
| UNIQUAC | 1-2 | -78.30 | -373.41 | -80.11 | -405.00 | 0.900 | 0.897 |
| 1-3 | 347.39 | 719.60 | 351.67 | 709.36 |
| 1-4 | 81.18 | 334.63 | 100.90 | 350.39 |
| 2-3 | 95.54 | 1638.88 | 90.63 | 1603.98 |
| 2-4 | 93.59 | 1086.76 | 101.23 | 1000.00 |
| 3-4 | 201.5 | -1046.80 | 200.65 | -1101.01 |
|  | | | | | | | |
| NRTL | 1-2 | -243.99 | -471.34 | -250.41 | -487.25 | 1.032 | 1.112 |
| 1-3 | 271.95 | 367.82 | 270.59 | 355.69 |
| 1-4 | 105.15 | 396.18 | 99.89 | 401.52 |
| 2-3 | 725.70 | 378.02 | 715.15 | 399.99 |
| 2-4 | 197.97 | 1018.56 | 208.75 | 1020.20 |
| 3-4 | 178.24 | -200.27 | 166.66 | -189.82 |

Table 4. *Continued*.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **System** | **Model** |  | **GA** | | **PSO** | |  | |
|  |  |  |  | GA | PSO |
| Ethanol (**1**)  Water (**2**)  Hexane (**3**)  Cyclohexane (**4**) | Wilson | 1-2 | -1279.71 | 113.26 | -1300.00 | 100.52 | 8.36 | 9.19 |
| 1-3 | -127.95 | 564.64 | 201.36 | 450.98 |
| 1-4 | 11.44 | 709.92 | 10.99 | 675.96 |
| 2-3 | 1719.78 | 307.01 | 1700.23 | 410.97 |
| 2-4 | 1191.66 | 1301.49 | 1016.32 | 1421.31 |
| 3-4 | -168.11 | 130.47 | -157.71 | 150.09 |
|  | | | | | | | |
| UNIQUAC | 1-2 | -516.84 | 100.04 | -520.36 | 110.10 | 1.125 | 1.199 |
| 1-3 | -75.66 | 459.06 | -75.11 | 460.00 |
| 1-4 | 10.92 | 366.66 | 11.90 | 350.09 |
| 2-3 | 1894.58 | 1019.36 | 1801.20 | 1000.82 |
| 2-4 | 279.39 | 1378.38 | 310.26 | 1352.87 |
| 3-4 | -120.74 | 112.64 | -152.28 | 100.90 |
|  | | | | | | | |
| NRTL | 1-2 | -536.41 | 985.73 | -500.25 | 1000.52 | 1.267 | 1.233 |
| 1-3 | -923.97 | 478.39 | -1001.05 | 490.67 |
| 1-4 | 144.25 | 383.18 | 150.58 | 390.67 |
| 2-3 | 1936.64 | 1360.98 | 1853.71 | 1429.70 |
| 2-4 | 294.54 | 232.63 | 300.02 | 250.09 |
| 3-4 | -309.51 | 119.46 | -320.11 | 125.09 |