**Supporting Information (ES0353964)**

Appendix A: Velocity Gradient Calculations.

Table S-1. Volatilization data of phenol from its binary-solute solution with *m*-cresol at 25 $^{o}$C.

Table S-2. Experimental $K_L$ values of benzene, toluene, ethylbenzene, and *o*-xylene from their multi-solute solutions at 25 $^{o}$C

Appendix A: Velocity Gradient Calculations

The velocity gradient $G$ ($s^{-1}$) is defined as

$$G = (P/V\mu)^{0.5}$$

where $P$ is the stirring power (W) for the solution, $V$ is the solution volume in the reactor vessel ($m^3$), and $\mu$ is the solution dynamic viscosity (N.m/s). For water at 25 $^oC$, $\mu$ = 0.000900 N.m/s. The stirring power is determined from

$$P = (C_D A \rho v^3)/2$$

where $C_D$ is the drag coefficient (approximately 1.8 for a blade moving perpendicular to the water solution), A is the blade area ($m^2$) and $\rho$ is the water-solution density (approximately 1000 $kg/m^3$), and $v$ is the velocity of the blade relative to water (m/s). The value of $v$ is related to the stirring rpm and blade diameter approximately as

$$v = (\text{rpm}/60)\pi D(0.75)$$

where $D$ is the blade diameter (m) and 0.75 is an empirical experimental constant. With the solution $V$ = 0.0001 $m^3$ and the blade $D$ = 0.06 m and $A$ = (0.06 m) (0.015 m) = 0.0009 $m^2$ in our experiments, the $G$ values calculated for stirring rates at 0, 20, 50, and 100 rpm stirring are 0, 31, 121, and 344 $s^{-1}$, respectively.

Table S-1. $K_L$ (cm/min), $k_L$ (cm/min), $k_GH$ (cm/min), and $\alpha$ values of phenol from its binary-solute solutions with *m*-cresol at 25 °C under various system settings[a].

| Air Speed = 0 m/s | $K_L$ | $\alpha$ | $k_L$ | $k_GH$ |
|---|---|---|---|---|
| Stirring: 0 rpm | 1.24E-4 | 1.02 | -6.20E-3 | 1.22E-4 |
| Stirring: 20 rpm | 1.52E-4 | 1.03 | -5.07E-3 | 1.47E-4 |
| Stirring: 50 rpm | 1.72E-4 | 1.05 | -3.44E-3 | 1.64E-4 |
| Stirring: 100 rpm | 2.29E-4 | 1.09 | -2.54E-3 | 2.10E-4 |
| Air Speed = 0.2 m/s | | | | |
| Stirring: 0 rpm | 1.24E-3 | 0.961 | 0.0318 | 1.29E-3 |
| Stirring: 20 rpm | 1.31E-3 | 0.963 | 0.0354 | 1.36E-3 |
| Stirring: 50 rpm | 1.46E-3 | 0.973 | 0.0541 | 1.50E-3 |
| Stirring: 100 rpm | 1.55E-3 | 0.975 | 0.0620 | 1.59E-3 |
| Air Speed = 2.0 m/s | | | | |
| Stirring: 0 rpm | 2.90E-3 | 0.884 | 0.0250 | 3.28E-3 |
| Stirring: 20 rpm | 3.29E-3 | 0.889 | 0.0296 | 3.70E-3 |
| Stirring: 50 rpm | 3.47E-3 | 0.904 | 0.0361 | 3.84E-3 |
| Stirring: 100 rpm | 3.64E-3 | 0.919 | 0.0449 | 3.96E-3 |
| Air Speed = 4.0 m/s | | | | |
| Stirring: 0 rpm | 4.53E-3 | 0.866 | 0.0338 | 5.23E-3 |
| Stirring: 20 rpm | 4.64E-3 | 0.879 | 0.0383 | 5.28E-3 |
| Stirring: 50 rpm | 4.85E-3 | 0.887 | 0.0429 | 5.47E-3 |
| Stirring: 100 rpm | 5.04E-3 | 0.895 | 0.0480 | 5.63E-3 |
| Air Speed = 6.0 m/s | | | | |
| Stirring: 0 rpm | 5.49E-3 | 0.817 | 0.0300 | 6.72E-3 |
| Stirring: 20 rpm | 5.89E-3 | 0.846 | 0.0382 | 6.96E-3 |
| Stirring: 50 rpm | 6.02E-3 | 0.828 | 0.0350 | 7.27E-3 |
| Stirring: 100 rpm | 6.37E-3 | 0.839 | 0.0396 | 7.59E-3 |

[a] See footnotes in Table 3 for calculations of $k_L$, $k_GH$, and $\alpha$ values. See also the pure-liquid $\bar{\beta}$ values in Table 3 for calculations of the $k_G$ values.

Table S-2. $K_L$ (cm/min) values of benzene, toluene, ethylbenzene, and *o*-xylene from their multi-solute solutions at 25 $^oC$ under various system settings[a]

| Air Speed = 0 m/s | Benzene | Toluene | Ethylbenzene | *o*-Xylene |
|---|---|---|---|---|
| Stirring: 0 rpm | 9.6E-3 | 9.0 E-3 | 8.3E-3 | 7.9E-3 |
| Stirring: 20 rpm | 0.0506 | 0.0485 | 0.0483 | 0.0452 |
| Stirring: 50 rpm | 0.0802 | 0.0778 | 0.0725 | 0.0662 |
| Stirring: 100 rpm | 0.114 | 0.112 | 0.108 | 0.0899 |
| Air Speed = 0.2 m/s | | | | |
| Stirring: 0 rpm | 0.0138 | 0.0129 | 0.0116 | 0.0114 |
| Stirring: 20 rpm | 0.0515 | 0.0500 | 0.0476 | 0.0432 |
| Stirring: 50 rpm | 0.0817 | 0.0804 | 0.0775 | 0.0702 |
| Stirring: 100 rpm | 0.119 | 0.119 | 0.109 | 0.0920 |
| Air Speed = 2.0 m/s | | | | |
| Stirring: 0 rpm | 0.0246 | 0.0233 | 0.0219 | 0.0212 |
| Stirring: 20 rpm | 0.0536 | 0.0519 | 0.0494 | 0.0489 |
| Stirring: 50 rpm | 0.0842 | 0.0836 | 0.0801 | 0.0719 |
| Stirring: 100 rpm | 0.121 | 0.123 | 0.111 | 0.0989 |
| Air Speed = 4.0 m/s | | | | |
| Stirring: 0 rpm | 0.0314 | 0.0307 | 0.0301 | 0.0279 |
| Stirring: 20 rpm | 0.0633 | 0.0565 | 0.0526 | 0.0510 |
| Stirring: 50 rpm | 0.0969 | 0.0953 | 0.0881 | 0.0756 |
| Stirring: 100 rpm | 0.126 | 0.124 | 0.118 | 0.101 |
| Air Speed = 6.0 m/s | | | | |
| Stirring: 0 rpm | 0.0398 | 0.0385 | 0.0375 | 0.0349 |
| Stirring: 20 rpm | 0.0640 | 0.0582 | 0.0560 | 0.0535 |
| Stirring: 50 rpm | 0.0981 | 0.0971 | 0.0906 | 0.0798 |
| Stirring: 100 rpm | 0.130 | 0.127 | 0.121 | 0.107 |

[a] See footnotes in Table 3 for the velocity gradients ($G$) at given stirring rates.