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## APPENDIX

**Mathematical Derivation of Equilbrium Selectivity of Hexene/n-Hexane on adsorbents in adsorption process**

Feed 1 = 1 gram of n-hexane + 1 gram of hexene + 18 grams of i-octane = 20 grams

Sample 1 = 1 gram of NaX-zeolite + feed 5 grams = 6 grams

Sample 2 = 1 gram of Silicalite + feed 5 grams = 6 grams

Sample 3 = feed 5 grams (no adsorbent)

<u>Weight % of each component in sample 3 by Gas Chromatography method</u>

1) hexene = 4.436 wt%
2) n-hexane = 4.361 wt%
3) i-octane = 91.203 wt%

$y_e$ = mass of hexene at start

$y_a$ = mass of hexane at start

$y_i$ = mass of i-octane at start

$y_e$ = (6*4.436)/100 = 0.266 gram

$y_a$ = (6*4.361)/100 = 0.262 gram

$y_o$ = (6*91.203)/100 = 5.472 grams

1. <u>Equilbrium Selectivity of Hexene/n-Hexane on NaX-zeolite (Sample 1)</u>

$x_i$ = mass of each component left in sample 1 after equilibrium adsorption

$M_s$ = mass of each component in solution

$M_a$ = mass of each component in adsorbent

<u>Weight % of each component left in sample 1 by Gas Chromatography method</u>

1) hexene = 2.761 wt%

2) n-hexane = 4.283 wt%

3) i-octane = 92.956 wt%

$x_e$ = mass of hexene left in solution

= (2.761/100)* Ms (A1)

$x_a$ = mass of n-hexane left in solution

= (4.283/100)*Ms (A2)

$x_o$ = mass of i-octane left in solution

= (92.956/100)*Ms (A3)

Mass of each component left in solution + Mass of each component in NaX-zeolite = $M_s+M_a$ = 6 grams (A4)

$z_i$ = Mass of each component in adsorbent

$z_e = y_e - x_e = 0.266 - x_e$ (A5)

$z_a = y_a - x_a = 0.262 - x_a$ (A6)

$z_o = y_o - x_o = 5.472 - x_o$ (A7)

<u>Assumption</u> No I-octane (solvent) in adsorbent

$\therefore z_o = 0$ gram

Substitute $z_o$ in (A7) $x_o$ = 5.472 grams

Substitute $x_o$ in (A3) $M_s$ = (5.472*100)/92.956 = 5.887 grams

Substitute $M_s$ in (A4) $M_a$ = 6-5.866 = 0.114 gram

From (A1) $x_e$ = (5.887*2.259)/100 = 0.1625 gram

From (A2) $x_a$ = (5.887*4.283)/100 = 0.2521 gram

Substitute $x_e$ in (A5) $z_e$ = 0.266-0.1625 = 0.1035 gram

Substitute $x_a$ in (A6) $z_a$ = 0.262-0.2521 = 0.0099 gram

To calculate equilibrium selectivity of hexene/n-hexane on NaX-zeolite adsorbent

$$\alpha\ (\text{hexene/n-hexane}) = \frac{\dfrac{\text{mass of hexene in adsorbent}}{\text{mass of hexene left in solution}}}{\dfrac{\text{mass of n-hexane in adsorbent}}{\text{mass of n-hexane left in solution}}}$$

$= (z_e/x_e)/(z_a/x_a)$ (A8)

$= (0.1035/0.1625)/(0.0099/\ 0.2521)$

$= 16.23$

2 Equlbrium Selectivity of Hexene/n-Hexane on Silicalite (Sample 2)

Weight % of each component in sample 3 by Gas Chromatography method is same as in case of NaX-zeolite.

$x_i$ = mass of each component left in sample 1 after equilibrium adsorption

Ms = mass of each component in solution

Ma = mass of each component in adsorbent

Weight % of each component left in sample 2 by Gas Chromatography method

1) hexene = 4.041 wt%

2) n-hexane = 4.002 wt%

3) i-octane = 91.897 wt%

$x_e$ = mass of hexene left in solution

= (4.041/100)* Ms (A9)

$x_a$ = mass of n-hexane left in solution

= (4.002/100)*Ms (A10)

$x_o$ = mass of i-octane left in solution

= (91.897/100)*Ms (A11)

Mass of each component left in solution + Mass of each component in Silicalite = $M_s$+$M_a$ = 6 grams (A12)

$z_i$ = Mass of each component in adsorbent

$z_e = y_e - x_e = 0.266-x_e$ (A13)

$z_a = y_a - x_a = 0.262-x_a$ (A14)

$z_o = y_o - x_o = 5.472-x_o$ (A15)

<u>Assumption</u> No i-octane (solvent) in adsorbent.

$\therefore z_o = 0$ gram

Substitute $z_o$ in (A15) $x_o$ = 5.472 grams

Substitute $x_o$ in (A11) $M_s$ = (5.472*100)/91.897 = 5.954 grams

Substitute $M_s$ in (A12) $M_a$ = 6-5.954 = 0.046 gram

From (A9) $x_e$ = (5.594*4.041)/100 = 0.2406 gram

From (A10) $x_a$ = (5.594*4.062)/100 = 0.2419 gram

Substitute $x_e$ in (A13) $z_e$ = 0.266-0.2406 = 0.0254 gram

Substitute $x_a$ in (A14) $z_a$ = 0.262-0.2419 = 0.0201 gram

<u>To calculate equilibrium selectivity of hexene/n-hexane on silicalite adsorbent</u>

From (A8) $\alpha$ (hexene/n-hexane) = $(z_e/x_e)/(z_a/x_a)$

= (0.0254/0.2406)/(0.0201/0.2419)

= 1.27

3. <u>Equilibrium Selectivity of Hexene/n-Hexane on AgX-zeolite (Sample 4)</u>

Feed 2 = 1 gram of n-hexane + 1 gram of hexene + 18 grams of i-octane = 20 grams

Sample 4 = 1 gram of AgX-zeolite + feed 5 grams = 6 grams

Sample 5 = feed 5 grams (no adsorbent)

<u>Weight % of each component in sample 5 by Gas Chromatography method</u>.

1) hexene = 3.837 wt%
2) n-hexane = 3.872 wt%
3) i-octane = 92.291 wt%

$y_e$ = mass of hexene at start

$y_a$ = mass of hexane at start

$y_i$ = mass of i-octane at start

$y_e$ = (6*3.837)/100 = 0.2302 gram

$y_a$ = (6*3.872)/100 = 0.2323 gram

$y_o$ = (6*92.291)/100 = 5.5375 grams

$x_i$ = mass of each component left in sample 4 after equilibrium adsorption

Ms = mass of each component in solution

Ma = mass of each component in adsorbent

<u>Weight % of each component left in sample 4 by Gas Chromatography method</u>

1) hexene = 1.966 wt%
2) n-hexane = 3.865 wt%
3) i-octane = 94.168 wt%

$x_e$ = mass of hexene left in solution

= (1.966/100)* Ms (A16)

$x_a$ = mass of n-hexane left in solution

= (3.865/100)*Ms (A17)

$x_o$ = mass of i-octane left in solution

= (94.168/100)*Ms (A18)

Mass of each component left in solution + Mass of each component in AgX-zeolite = $M_s+M_a$ = 6 grams (A19)

$z_i$ = Mass of each component in adsorbent

$z_e = y_e - x_e = 0.2302 - x_e$ (A20)

$z_a = y_a - x_a = 0.2323 - x_a$ (A21)

$z_o = y_o - x_o = 5.5375 - x_o$ (A22)

<u>Assumption</u> No i-octane (solvent) in adsorbent.

$\therefore\ z_o = 0$ gram

Substitute $z_o$ in (A22) $x_o$ = 5.5375 grams

Substitute $x_o$ in (A18) $M_s$ = (5.5375*100)/94.168 = 5.887 grams

Substitute $M_s$ in (A19) $M_a$ = 6-5.887 = 0.113 gram

From (A16) $x_e$ = (5.887*1.966)/100 = 0.1157 gram

From (A17) $x_a$ = (5.887*3.865)/100 = 0.2275 gram

Substitute $x_e$ in (A20) $z_e$ = 0.2302-0.1157 = 0.1145 gram

Substitute $x_a$ in (A21) $z_a$ = 0.2323-0.2275 = 0.0048 gram

<u>To calculate equilibrium selectivity of hexene/n-hexane on AgX-zeolite adsorbent.</u>

From (A8) α (hexene/n-hexane) = $(z_e/x_e)/(z_a/x_a)$

= (0.1157/0.1145)/(0.0048/ 0.2275)

= 47.8926

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