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APPENDICES

APPENDIX A Calculation of Sample Preparation

A1 Amount of Metal Chemical for Impregnation

Example: Amount of 100% monolayer of $CuCl_2$ chemical for impregnation on macroporous alumina (Concentration of metal is corresponded to monolayer of $CuCl_2$ on macroporous alumina surface)

From

Monolayer of CuCl on alumina surface = 0.095 g CuCl/100 m^2 of alumina

Surface area of macroporous alumina = 194 m^2/g

Monolayer of CuCl on alumina surface $= \frac{0.095 \times 194}{100}$

= 0.184 g CuCl/1 g of alumina

Molecular weight of CuCl = 98.999 g/mole

Thus, monolayer of CuCl on alumina surface $= \frac{0.184}{98.999}$

= 0.00186 mole CuCl/1 g of alumina

From

$CuCl_2$ was used as the same molar concentration of CuCl.

Molecular weight of $CuCl_2$ = 134.45 g/mole

Thus, monolayer of $CuCl_2$ on macroporous alumina surface

= 0.00186 mole $CuCl_2$ /1 g of alumina

$= 0.00186 \times 134.45$

= 0.250 g $CuCl_2$ /1 g of alumina

From

Pore volume of macroporous alumina = 0.674 cm^3/g of alumina

Amount of $CuCl_2$ used $= \frac{0.250}{0.674}$

Thus, amount of $CuCl_2$ used = 0.371 g $CuCl_2/cm^3$ of alumina

Then, 75% monolayer = 0.278 g $CuCl_2/cm^3$ of alumina

And, 50% monolayer = 0.186 g $CuCl_2/cm^3$ of alumina

A2 Simulated Diesel Fuel Preparation

Example: Preparation of 1000 cm^3 simulated diesel (80%wt. Dodecane, 20%wt. Toluene and 150 ppmw of Dibenzothiophene)

From

Density of Dodecane = 0.75 g/cm^3

Density of Toluene = 0.8669 g/cm^3

Molecular weight of Dibenzothiophene (DBT) = 184.26

Density of simulated diesel $= \left(\frac{80 \times 0.75}{100}\right) + \left(\frac{20 \times 0.8669}{100}\right)$

So, density of simulated diesel = 0.77338 g/cm^3

Weight of simulated diesel $= 0.77338 \times 1000$

So, weight of simulated diesel = 773.38 g

Amount of Dodecane $= \left(\frac{80}{100}\right) \times 773.38 = 618.704$ g

Amount of Toluene $= \left(\frac{20}{100}\right) \times 773.38 = 154.676$ g

Dibenzothiophene concentration = 150 ppmw

$= \frac{150}{10^6}$

= 0.00015 g of S/g of simulated diesel

$= \frac{0.00015}{32}$

$= 4.6875 \times 10^{-6}$ mole of S/g of simulated diesel

$= (4.6875 \times 10^{-6}) \times 184.26$

$= 8.6374 \times 10^{-4}$ g of DBT/g of simulated diesel

Amount of Dibenzothiophene $= (8.637 \times 10^{-4}) \times 773.38$

So, amount of Dibenzothiophene = 0.6680 g

APPENDIX B Calculation of Amount of Adsorption of Sulfur Compounds in Dynamic Adsorption Experiment

B1 Death-Volume of Fixed Bed Reactor

To find out the death-volume of fixed bed reactor, the breakthrough curve of simulated diesel fuel (80% dodecane, 20% paradiethylbenzene and 150 dibenzothhiophene) without adsorbent was performed in this study. By applying first moment of the breakthrough curve (μ), we can determine the death-volume:

$$\mu_1 = \mu = \int_0^{\infty}(1-y)dV \qquad y = \frac{c(V)}{c_0}$$

Where μ: mean breakthrough volume

C: concentration of sulfur compounds in the feed (mole or g)

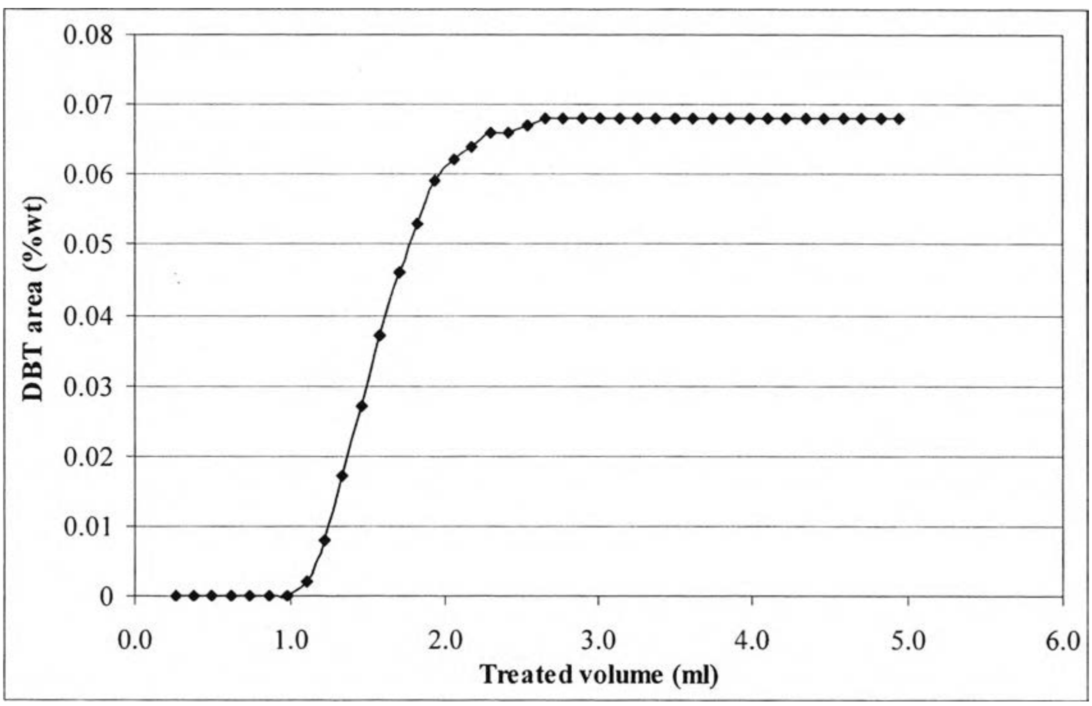

Figure B1. Breakthrough curve without adsorbent.

Hence, Death-volume = μ = 1.591 ml

B2 Amount of Adsorption of Sulfur Compounds in Dynamic Adsorption Experiment

Example: Adsorption of dibenzothiophene in simulated diesel fuel (80% dodecane, 20% Toluene and 150 ppmw sulfur content) on 100% monolayer of $CuCl_2$ on m-Al_2O_3 which crushed after impregnation at diameter size 300-500 μm.

Setting parameter of breakthrough adsorption experiment:

Number of the collected vials	= 60
Collected time	= 0.50 min
Waste time	= 3.98 min
Wait time	= 5.39min
Flow rate (F)	= 0.4 cm^3/min
Death-volume	= 1.591 cm^3
Diameter of grain	= 0.25 mm
Structural density (ρ_S)	= 3.085 g/cm^3
Macroporous volume (V_M)	= 0.013 cm^3/g
Mesoporous volume (V_m)	= 0.545 cm^3/g
Microporous volume (V_μ)	= 0.000 cm^3/g
Mass of adsorbent	= 6.00 g
Density of simulated diesel fuel (d)	= 0.774 g/cm^3
Particle density (ρ_P)	= 1.096 g/cm^3
Bulk density (ρ_B)	= 0.740 g/cm^3
C_0 (DBT)	= 150 ppm

T_a = Waste time + Wait time/2

= 6.675 min

T_p = Total time / Numbers of vials

= 5.86 min

u (superficial liquid velocity in empty column, cm/min)

= flow rate / column section

= 0.510 cm/min

Particle porosity (ε_P) = Partical density × V_M

= 0.014

Interparticle porosity (ε_I) = $1-\left(\dfrac{\rho_B}{\rho_P}\right)$

= 0.326

Total Macroporous volume = V_M × Mass of adsorbent

= 0.078 cm^3

Total Microporous volume = V_μ × Mass of adsorbent

= 0.000 cm^3

Total Macroporous and Microporous volume

= 0.078 cm^3

Total Bed porosity (ε_B) = Total Macroporous and Microporous volume/ Volume of column

= 0.335

At the Collected vials number i:

Average time = $T_a + \left(i - \dfrac{1}{2}\right) \times T_P$

Average volume of fuel = $(T_a \times F) + \left(i - \dfrac{1}{2}\right) \times T_P \times F$

Amount of treated volume = Average volume of fuel – Death volume

Hence, Cumulative effluent volume of DBT

= μ_{DBT}

= 49.351 cm^3

= 49.351 cm^3 / 6 g of adsorbent

= 8.225 cm^3g-adsorbent

Amount of DBT in the column (M_{DBT})

$= \mu_{DBT} \times d_{DBT} \times C_0$

= 0.031 g

Amount of DBT adsorbed $= M_{DBT} \times (1 - \varepsilon_B)$

= 0.031 g

= 0.031 × 1000/6 g of adsorbent

= 5.1238 mg/g-adsorbent

= 5.1238 / molecular weight of DBT

= 0.0278 mmole/g-adsorbent

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2. Publication

- Pat SOOKSAEN, Supakij SUTTIRUENGWONG, Kunwadee ONIEM, Khanamporn NGAMLAMIAD and Jitlada ATIREKLAPWARODOM, Fabrication of Porous Bioactive Glass-Ceramics via Decomposition of Natural Fibres, Journal of Metals, Materials and Minerals, Vol. 18 No. 2 pp.85-91 (2008).

3. Conference

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